Technical Specifications
For
Border Crossing Facilities

Engineering data includes the following:

(a) Mileage, size of pipeline and interconnections;

The limited border crossing segment shall consist of approximately forty (40) feet on each side of the International Boundary and shall be buried to a minimum depth of three (3) feet below ground level; such segment shall connect at the international boundary line with like facilities in the Province of Manitoba, Canada.

(b) Specifications for pipe (diameter, length, wall thickness, grade) and valves (diameter and American National Standards Institute rating) with the maximum allowable operating pressure for each;

Pipe will be 36-inch outside diameter, 0.3750- to 0.469-inch wall thickness, API 5L Grade X70, double submerged-arc (DSAW) steel pipe and manufactured in accordance with Enbridge's specifications EES103-2006 enclosed herewith as Exhibit C.b.1. The maximum allowable operating pressure will be 1313 psig.

The valves to be installed will be 36-inch ANSI 600, weld end by weld end, full port, rising stem gate valves. These valves will be manufactured in accordance with API Standard 6D "API Specification for Steel, Gate, Plug, Ball and Check Valves for Pipeline Service," and Enbridge specifications EES105-2006 enclosed herewith as Exhibit C.b.2. The maximum allowable operating pressure of the valve will be 1440 psig.

EXHIBIT C.b.1

Enbridge Specifications EES103-2006

EES103 – 2006

Submerged-Arc-Welded Steel Pipe Specification

Supplementary to API 5L

Revision: 0
Prepared By: Vincent Chou
Approval Date: August 4, 2006

1 Scope

1.1 PURPOSE AND COVERAGE

1.1.1

This Specification is prepared to be used in conjunction with API Specification 5L, Specification for Line Pipe, Forty-third Edition, March 2004, for the manufacture, qualification, inspection, and testing of submerged-arc welded steel line pipe for use in transportation of sweet service hydrocarbon fluids, and covers the requirements that are in addition to those specified in API 5L.

All pipe shall meet the minimum requirements of API 5L, Forty-third Edition.

In the event that conflict exists between this Specification and the requirements in API 5L, Forty-third Edition, the more stringent of the requirements shall apply.

The numbering of clauses in this Specification corresponds, where possible, to that in API 5L, Forty-third Edition when the subject is covered in that specification, and any additional clauses are numbered sequentially.

The requirements of the Appendices to this Specification shall also be met when applicable.

1.1.2

Pipe shall be supplied to meet the additional requirements outlined on the Specification Data Sheet(s) issued as applicable to each order, and on purchase order documentation applicable to each order.

1.2 PRODUCT SPECIFICATION LEVEL (PSL)

Pipe shall meet the level of technical requirements (product specification level) designated as PSL 2.

3 Definitions

For the purposes of this Specification, the following additional definitions shall also apply:

3.9 manufacturer: a pipe manufacturer who proposes to, or has been contracted to provide to the purchaser, pipe manufactured to this Specification.

3.20 purchaser: that company, which is stated on the Specification Data Sheet(s) as purchaser, and shall include their engineering agencies, and other designated authorized representatives.

3.21 Specification Data Sheet(s): information issued to the prospective manufacturer in a format as outlined in Appendix B of this Specification, including information issued to the manufacturer on purchase order documentation or on any request-for-quotation documentation associated with a specific project.

3.22 crack: a stress-induced separation of the metal which, without any other influence, may be insufficient in extent to cause complete rupture of the material

3.23 single-jointer: two pieces of pipe welded together to make a length shorter than 50 ft. (15.2 m)

3.24 double-jointer: two pieces of pipe welded together to make a length 50 ft. (15.2 m) or longer

3.25 triple-jointer: three pieces of pipe welded together to make a length 50 ft. (15.2 m) or longer

4 Information to be Supplied by the Purchaser

4.4 Specification Data Sheet(s) supplied for each order shall include applicable information outlined in Clauses 4.1, 4.2, and 4.3 of API 5L. It shall remain the responsibility of the manufacturer to clarify and submit as part of each specific quotation for supply, any proposed specific requirements of Clauses 4.1, 4.2, and 4.3 of API 5L not issued in the request for quotation.

5 Process of Manufacture and Material

5.1 PROCESS OF MANUFACTURE

Pipe furnished to this specification shall be submerged-arc welded as defined in Clauses 5.1.2.2.1, 5.1.3.5, and 5.1.3.11 of API 5L as applicable.

5.1.2 Welding Processes

5.1.2.3 Welding Procedure Qualification

Welding procedures for the longitudinal, helical, skelp end, and circumferential jointer welds, whichever are applicable, shall be qualified in accordance with the requirements of the latest edition of ASME Boiler and Pressure Vessel Code, Section IX for each welding process, and for each flux trade name/designation and electrode designation combination employed.

5.1.2.3.1

Material grade shall be included as an essential variable for qualification of welding procedures in accordance with ASME Boiler and Pressure Vessel Code, Section IX.

5.1.2.3.2

For pipe ordered with proven notch toughness properties, procedure qualification testing shall include Charpy V-notch impact tests of the weld and heat-affected zone. The absorbed energy requirements shall be as outlined on Specification Data Sheets.

5.1.2.3.3

Procedure qualification tests shall include at least three microhardness traverses across the weld, heat-affected zones, and parent material. One traverse shall be within 1/8" (3 mm) of the outside surface, one traverse shall be at the mid-wall point, and one traverse shall be within 1/8" (3 mm) of the inside surface. All readings in each zone shall be performed on the hardest-appearing structure. All hardness tests shall meet requirements outlined in clause 6.2.7 of this specification.

5.1.2.3.4

Utilization of pre-qualified welding procedures shall be permitted, if qualification documentation meets requirements of this Specification, and is submitted to the Purchaser and

approved prior to start of production. Welding procedures qualified as part of production shall be documented and submitted to the Purchaser not later than seven days after the start of production.

5.1.5 Repair Welding

Defects in the longitudinal, helical , or circumferential seams, or in skelp end welds of submerged-arc welded pipe, shall be subjected to weld repair in accordance with requirements in Appendix B of API 5L. In addition to requirements outlined in B.3 of Appendix B of API 5L, the following requirements shall apply:

- The maximum length of any repair shall be 10 in. (250 mm).
- The minimum distance of a repair weld from the pipe end shall be 12 in. (300 mm).
- The minimum distance between any two repaired weld locations shall be 12 in. (300 mm).
- There shall not be more than 2 repairs in any 20 ft. (6 m) of weld.
- Back-to-back repairs shall not be permitted.
- Additional repair to a previously-repaired area shall not be permitted.

5.1.5.1 Repair Welding Procedure Qualification – Additional Tests

Repair welding procedure qualifications shall be carried out in accordance with requirements outlined in ASME Section IX, and in accordance with requirements outlined in Appendix C of API 5L.

Hardness tests shall be performed in general accordance with, and meet the requirements of Clause 6.2.7 of this specification.

For pipe ordered with proven notch toughness properties, repair welding procedure qualification tests shall include Charpy V-notch tests of the weld and heat affected zone. Energy absorption requirements and test temperature for notch toughness tests shall be as specified for pipe welds.

5.3 MATERIAL

5.3.3 Steel Deoxidation Practice

All pipe shall be made from killed steel.

5.3.4 Plate or Skelp Inspection

Coincident with submission of quotation, the Manufacturer shall provide details of procedures to be utilized for the ultrasonic inspection of skelp or pipe for the detection of laminar discontinuities in the steel. Acceptance criteria relating to defect size shall be included with the procedure, and shall be approved by the Purchaser prior to commencement of production.

5.7 Manufacturing Procedure Specification (MPS)

As part of the quotation for supply of line pipe under this Specification, the Manufacturer shall submit a Manufacturing Procedure Specification (MPS) providing the information including, but not limited to, that listed in Appendix A of this Specification. The Manufacturing Procedure Specification shall be approved by the Purchaser prior to commencement of

production, and any subsequent changes to the Manufacturing Procedure Specification shall be approved by the Purchaser in writing prior to implementation.

6 Material Requirements

6.1 CHEMICAL PROPERTIES

6.1.1 Chemical Composition

6.1.1.1 Heat and Product Analysis

In addition to requirements outlined in API 5L, heat and product analysis shall conform to the requirements of Table 1 following:

Table 1

Element	Symbol	Maximum % Element
Carbon	C	0.13
Manganese	Mn	**
Phosphorus	P	0.020
Sulphur	S	0.008
Silicon	Si	0.40
Copper	Cu	0.40
Nickel	Ni	0.70
Chromium	Cr	0.30
Molybdenum	Mo	0.40
Niobium	Nb	0.10
Titanium	Ti	0.030
Aluminum (total)	Al	0.12
Vanadium	V	0.09
Nitrogen	N	**
(Niobium + Vanadium)	(Nb + V)	0.12
(Manganese+Chromium+Molybdenum)	(Mn+Cr+Mo)	**

**** limitations on constituents Mn, (Mn+Cr+Mo), & N:**

Carbon (C) Content	Manganese (Mn) Maximum	(Mn+Cr+Mo) Maximum	Nitrogen (N) Maximum
≥.09	1.75	2.15	0.012
.08	1.80	2.20	0.012
.07	1.95	2.35	0.012
.06	1.95	2.35	0.013
.05	2.00	2.40	0.014
≤.04	2.00	2.40	0.015

6.1.3 Carbon Equivalent

6.1.3.2 Maximum Carbon Equivalent

For all pipe, the carbon equivalent shall not exceed CE (*Pcm*) of 0.22%, or CE(*IIW*) of 0.38%, whichever is applicable.

6.2 MECHANICAL PROPERTIES

6.2.1 Tensile Properties

6.2.1.1 Body Tensile Range

The range of actual yield strengths based on laboratory qualification testing shall not exceed 15,000 psi (104 MPa) for each pipe order of a specific diameter, wall thickness and grade.

6.2.1.2 Yield Ratio

The ratio of yield strength to ultimate tensile strength (Y/T ratio) shall not exceed .90.

6.2.5 Fracture Toughness Tests

6.2.5.3 Supplementary Fracture Toughness Tests

6.2.5.3.1 Supplementary Fracture Toughness Tests – Pipe Body

For pipe ordered with proven notch toughness properties, the following requirements shall apply:

(i) Pipe shall be tested to requirements of SR5, SR6, and SR19 of API 5L, Forty-third Edition, as outlined on Specification Data Sheets.

(ii) Pipe material shall exhibit an absorbed energy (full size equivalent) as outlined in SR19, and also as outlined on Specification Data Sheets.

(iii) Drop-weight tear tests shall exhibit a fracture shear area of 60% minimum for any test, with no individual test specimen exhibiting less than 50% shear, except that for each order of a specific diameter, wall thickness and grade supplied using material from five or more heats of steel, the all-lot average shear area shall not be less than 85%. Shear area shall be reported for each individual Drop-weight Tear Test specimen.

6.2.5.4 Supplementary Fracture Toughness Tests - Weld Metal and Heat Affected Zones

For pipe ordered with proven notch toughness properties, longitudinal, helical, skelp end welds and circumferential mill welds, as well as heat affected zones, shall exhibit absorbed energies as outlined on the Specification Data Sheet(s).

6.2.7 Hardness Tests

Unless specified otherwise on the Specification Data Sheet(s), the hardness in the weld, heat affected zone and base metal shall not exceed 350 HV_{500}, as determined using test methods in accordance with ASTM E384.

The results of all hardness tests shall be reported.

7 Dimensions, Weights, Lengths, Defects, and End Finishes

7.2 DIAMETER

Tolerances for diameter of the pipe body and for diameter of the pipe ends shall be in accordance with requirements of Table 7 and Table 8 respectively of API 5L, except that the diameter tolerances shall not exceed minus 1/32" (0.8 mm) or plus 1/8" (3.2 mm) at any location along the length of the pipe.

7.2.1 Out-of-Roundness

For all pipe sizes and D/t ratios, the maximum difference between the lengths of the major and minor axes at any point along the pipe shall not exceed the lesser of 2% of the nominal outside diameter or 0.500" (12.7 mm).

7.3 WALL THICKNESS

The under-tolerance on wall thickness shall be 5% of the specified nominal wall thickness.

7.5 LENGTH

Length tolerances shall be as outlined on the Specification Data Sheet(s).

7.6 STRAIGHTNESS

Deviation from a straight line shall not exceed 0.2% of the length, as applied along any 10 ft. (3 m) section of each pipe.

7.7 JOINTERS

It shall be acceptable to furnish mill jointers, subject to requirements of Appendix A of API 5L, and to requirements of this Specification.

7.7.1 Transverse Weld Tensile Tests – Jointer Welds

For circumferential mill jointer welds, tests shall be conducted at a frequency of one test per lot of 500 welds, and shall meet the ultimate tensile strength requirements of Table 3B of API 5L for the applicable grade of pipe.

7.7.2 Guided Bend Tests – Jointer Welds

For circumferential mill jointer welds, face and root guided-bend tests shall be conducted in accordance with Clause 9.10.3 of API 5L, at a frequency of one test per lot of 500 welds.

7.7.3 Single-jointers

It shall be permissible to furnish single-jointers as defined in Clause 3.23 of this specification to a maximum of 5% of each order item.

7.7.4 Double-jointers

It shall be permissible to furnish double-jointers as defined in Clause 3.24 of this specification for an entire order or any portion thereof.

7.7.5 Triple-jointers

It shall be permissible to furnish triple-jointers as defined in Clause 3.25 of this specification to a maximum of 5% of each order item.

7.8 WORKMANSHIP AND DEFECTS

7.8.1 Dents

Plain dents deeper than ¼" (6.4 mm) and located in the pipe body, measured as the gap between the lowest point of the dent and a prolongation of the original contour of the pipe, or having a length in any direction exceeding one-half the pipe diameter, or both, shall be considered to be defects and shall be cut out as a cylinder.

All cold-formed dents deeper than 1/8 in. (3.2 mm) with a sharp bottom gouge shall be considered as defects, and shall be cut out as a cylinder or shall be removed by grinding.

Dents on welds shall not be permitted, and shall be cut out as a cylinder.

7.8.9 Cracks, Sweats, and Leaks

All cracks, sweats and leaks shall be considered defects. Cracks as defined in this Specification shall be considered to be defects regardless of dimensions, and shall be cut out as a cylinder.

7.8.14 Other Defects

Any imperfection on either of the external wall or internal wall surfaces of the pipe, and having a depth that results in a remaining wall thickness at any point of less than 95 per cent of the specified nominal wall thickness, shall be considered to be a defect.

7.8.14.1

Surface scores (sharp notches, gouges, scores, slivers, etc.) and all stress raising imperfections shall be removed by grinding even though they may be less than the maximum depth permissible for imperfections.

7.8.14.2

Pipe ordered to this Specification may be externally coated utilizing fusion bond epoxy or similar methods. Slivers, scabs, bristles or other surface imperfections that could result in an unacceptable applied coating shall be considered to be surface defects, and shall be removed by grinding or by other means acceptable to the purchaser.

7.8.15 Geometric Deviations

Geometric deviations from the normal cylindrical contour of the pipe which occur as a result of the pipe forming process or manufacturing operations (e.g. flat spots, peaks) shall not exceed 1/8" (3 mm), measured as the gap between the extreme point of the deviation and the prolongation of the normal contour of the pipe.

7.8.16 Grinding

The minimum remaining wall thickness at any point after grinding shall not be less than 95 per cent of the specified nominal wall thickness.

7.9 PIPE ENDS

7.9.3 Plain Ends

Unless otherwise specified on Specification Data Sheet(s), the root face dimension shall be 1/16“ (1.6 mm) plus 1/32“ (0.8 mm) minus 0” (0.0 mm) for 95 per cent of the circumference of each pipe end.

Both ends of submerged-arc welded pipe shall have the inside weld reinforcement removed for a minimum distance of 3” (75 mm) from the end of the pipe, such that the inside weld bead does not extend above the inside surface of the pipe by more than 0.020” (0.5 mm).

Where specified on Specification Data Sheet(s), both ends of submerged-arc-welded pipe shall have the outside weld reinforcement removed for a distance of at least 5” (125 mm) from the end of the pipe, such that the outside weld bead does not extend above the outside surface of the pipe by more than 0.010” (0.25 mm)

9 Inspection and Testing

9.3.5 Fracture Toughness Tests

9.3.5.4 Charpy Testing Frequency – Welds

For pipe ordered with proven notch toughness properties, Charpy V-notch impact tests shall be conducted on the weld and heat affected zone of longitudinal, helical, skelp end welds and circumferential welds. For longitudinal, helical and skelp end welds, the test frequency shall be the same as that required for weld tensile tests in Table 13 of API 5L. For circumferential mill jointer welds, the test frequency shall be once per 500 welds completed.

9.3.6 Hardness Tests

Microhardness testing shall be performed at applicable frequencies as follows:

a) For longitudinal and helical welds: one test per welding day per O.D. welder, and at least once for each heat of material supplied for an order;
b) For skelp end welds: one test per lot of 100 lengths containing skelp end welds;
c) For circumferential mill welds: one test per lot of 500 welds.

Microhardness tests shall be performed in accordance with ASTM E384, at locations identical to those as outlined in clause 5.1.2.3.3 above, and shall meet requirements of Clause 6.2.7 of this Specification.

9.4 HYDROSTATIC TESTS

9.4.1 Hydrostatic Test Requirements

The pressure of the hydrostatic test medium shall stress the pipe wall to at least 95% of the specified minimum yield strength (SMYS). Test pressure shall be held constant for not less than 10 seconds.

9.4.2 Verification of Hydrostatic Test

9.4.2.1

The individual pressure recordings shall be unambiguously traceable to each pipe section tested.

9.4.2.2

Hydrostatic test gages shall be calibrated with a device approved by the Purchaser, and shall be calibrated prior to commencement of production, weekly thereafter, and after all hydrostatic bursts.

9.4.3 Test Pressures

9.4.3.1

Any proposals to determine test pressure by applying end load compensation in accordance with the requirements of Appendix K of API 5L, shall be indicated at the time of submission of proposals for supply.

9.4.5 Investigation of Test Failure

Each hydrostatic test failure shall be investigated, and the cause of each failure determined and fully documented. Documented failure investigation results shall be forwarded to the Purchaser.

9.6 SURFACE INSPECTION

Visual inspection shall include, but not be limited to, examination of:

a) The entire external surface including the weld zone, by the inspector(s) walking the full length of the pipe;
b) the internal surface by crawling each pipe, except that for pipe of diameter 20" (508 mm) and smaller, internal surface inspection may be performed from each end using adequate lighting; and
c) the pipe ends.

9.6.1

All pipe shall be visually inspected.

9.6.2

The external and internal surfaces of the pipe shall be presented for final visual inspection free of oil, grease, lubricant, flux, loose mill scale or other foreign matter.

9.8 NONDESTRUCTIVE INSPECTION

9.8.3 Methods of Inspection

Longitudinal and helical weld seams shall be inspected for internal and external longitudinal and transverse imperfections by ultrasonic methods, in accordance with requirements of API 5L and this Specification.

Skelp end welds shall be inspected for longitudinal and transverse imperfections by radiological methods in accordance with API 5L, by ultrasonic methods utilizing procedures approved by the Purchaser, or by a combination of radiological and ultrasonic methods. Fluoroscopic inspection shall not be accepted for specification compliance.

Repair welds shall be inspected by radiological methods in accordance with Clause 9.8.4 of API 5L, except that fluoroscopic inspection shall not be accepted for specification compliance.

Circumferential jointer welds produced by double submerged arc welding shall be inspected for longitudinal and transverse imperfections by radiological methods in accordance with Clause 9.8.4 of API 5L, by ultrasonic methods in accordance with requirements of API 5L and this Specification, or by a combination of radiological and ultrasonic methods, except that fluoroscopic inspection shall not be accepted for specification compliance. Standards of acceptability for circumferential jointer welds shall be in accordance with the requirements of the latest edition of API 1104.

The junctions of jointer welds and other submerged-arc-welds shall be inspected by film radiography or non-film radiological imaging techniques, or by ultrasonic inspection methods. Fluoroscopic inspection shall not be accepted for specification compliance. Standards of acceptability for the junctions of jointer welds and other submerged arc welds shall be in accordance with the requirements of Clause 9.8.4.6 of API 5L, or Clause 9.8.5.4 of this Specification, whichever is applicable, and shall also be in accordance with requirements of Clause 7.8.12 of API 5L.

The location of equipment in the manufacturer's facility shall be such that all nondestructive inspection for compliance to specification requirements shall be performed after final hydrostatic testing.

9.8.3.3 Removal of Markings from Nondestructive Inspection

For all nondestructive inspection applied for specification and production control purposes, any paint markings applied to the pipe to mark locations where alarm limits were exceeded, or where imperfections were noted, shall be removed or painted over with black paint, as an indication that imperfections have been investigated for compliance to all requirements of this Specification.

9.8.3.4 Nondestructive Inspection Procedure Documentation

All nondestructive inspection procedures to be applied for specification compliance and for production control purposes shall be documented and submitted by the Manufacturer as part of the quotation for supply, and shall be approved by the Purchaser prior to implementation.

9.8.3.5 Additional Nondestructive Inspection of Pipe Ends

The finished bevel of all pipe ends shall be inspected for seams and laminations using an ultrasonic, liquid penetrant, or magnetic particle inspection method. Acceptance criteria shall be as outlined in Clause 7.8.10 of API 5L.

9.8.5 Ultrasonic Inspection

9.8.5.2 Ultrasonic Inspection Reference Standards

Reference standards shall contain machined calibration reflectors as follows:

- 1/16" (1.6 mm) radially drilled hole, for application of acceptance limits and for setting of alarm levels applicable to longitudinal and transverse defect inspection;

- rectangular notches; ID and OD, longitudinal orientation, depth 5.0% of specified wall thickness, dimensional tolerances as specified in Table 26 of API 5L, for the verification that the sound beam for longitudinal defect inspection is being directed perpendicular to the weld line

9.8.5.4 Acceptance Limits

For inspection of the pipe welds, imperfections that produce a signal greater than the applicable acceptance limit signal given in Table 23 of API 5L for the 1/16" (1.6 mm) radially drilled hole shall be considered defects, and shall be dispositioned in accordance with Clause 9.9 of API 5L.

9.8.7 Residual Magnetism Measurement Requirements

In addition to the requirements of Clause 9.8.7 of API 5L, the Manufacturer shall ensure that the measured flux density from residual magnetism induced into the pipe as a result of forming, welding, inspection, or any other aspect of the manufacturing process does not exceed 30 Gauss (3 mT).

9.12 RETESTS

9.12.7 Hardness Retests

In the event of a hardness test failure, a documented proposal for the location and number of retests shall be prepared by the Manufacturer and submitted for approval by the Purchaser.

9.14 RIGHT OF REJECTION

Where more than 50% of the pipe from any heat, heat treat lot or qualification lot is rejected due to a combination of defects in the steel, skelp or finished pipe, mechanical test failures, nondestructive inspection rejects or other deficiencies, the Purchaser reserves the right to reject all remaining pipe supplied from the affected lot.

10 Marking

10.1 GENERAL

10.1.3 Additional Markings and Method Of Application

The pipe number, length, and heat number (or code traceable to the heat number) shall be legibly stenciled on the inside of both ends of each pipe.

Any additional requirements for marking shall be outlined on the Specification Data Sheet(s).

12 Documents

12.1 CERTIFICATION

12.1.2 PSL 2 Certification Requirements

The Manufacturer shall, within seven days of completion of each mill run, supply material test certificates in a format approved by the Purchaser, and in accordance with requirements of this Specification.

12.1.2.1

Supply of material test certificates shall be a condition of acceptance and payment for pipe.

12.1.2.2

The reports and certificates shall provide information as specified in SR 15.1 of API 5L, and shall include the following additional information:

j) Tensile test results applicable to Y/T ratio and transverse weld tensile tests,
k) Qualification pipe number for each test;
l) Deoxidation practice for steel;
m) Certification of hydrostatic test including duration and pressure;
n) Certification of completion of guided bend tests;
o) Certification that nondestructive inspection was performed in accordance with, and met the requirements of this Specification and the approved Manufacturing Procedure Specification (MPS);
p) Certification correlating pipe number to heat number and plate number; and,
q) Certification that the pipe has been manufactured in accordance with the Manufacturing Procedure Specification (MPS), API 5L, and this Specification.

14 Purchaser Inspection

14.1

The provisions of Appendix H of API 5L shall apply.

14.2

The Manufacturer shall allow free access to the Purchaser to all steelmaking and rolling mill facilities providing skelp for the pipe order.

14.3

The Purchaser may arrange under separate contract with one or more third party agencies to conduct supervisory, visual, mechanical, electromagnetic, ultrasonic or other types of inspection in the pipe mill, rolling mill, or steel mill. The Manufacturer shall supply acceptable space to the Purchaser as may be necessary for the performance of this work.

14.4

The Manufacturer shall permit access by the Purchaser to all specimens and test records applicable to specification-compliance testing and production control testing during the manufacture of steel, skelp and pipe.

APPENDIX A – MANUFACTURING PROCEDURE SPECIFICATION REQUIREMENTS

The Manufacturing Procedure Specification submitted shall include, as a minimum, the following detailed information:

i) steel source, including steelmaking method, heat size, deoxidation practice, inclusion shape control practices, and casting method;
ii) aim chemistries and chemical limits for all elements referenced in Clause 6.1.1.1 of this Specification, and as applicable to pipe of each diameter, wall thickness and material grade to be made for the order;
iii) skelp rolling source, specific rolling and forming practices, including where applicable, typical reduction schedules, final finishing temperatures, and facilities for thermo-mechanical controlled rolling and on-line accelerated cooling;
iv) skelp inspection procedures;
v) details of forming procedures;
vi) pipe manufacturing location, and any plant limitations on wall thickness, diameter, and material grade;
vii) typical welding parameters and consumable combinations applicable to longitudinal, helical, skelp end, repairs, and circumferential jointer welds;
viii) a description of the quality organization applicable to steelmaking, casting, skelp rolling and pipe manufacturing facilities, including identification of reporting practices, verification mechanisms to assure product traceability in accordance with requirements of SR 15.2 of API 5L, and responsibility for customer contact related to commercial and quality matters;
ix) a flow chart for pipe manufacturing, finishing, and qualification processes;
x) normal mill control tolerances on all specification dimensions for pipe;
xi) laboratory test equipment present at the manufacturing plant for testing of material properties for the order;
xii) all nondestructive inspection procedures utilized for specification compliance and for production control, as applicable to skelp, pipe body, and welds
xiii) method and typical amount of cold expansion as applicable;
xiv) facilities available for external or internal coating in-house or by a third party;
xv) yard handling, storage, and shipping procedures, including drawings of proposed methods of stacking and securing pipe for shipment and method of end protection; and,
xvi) facilities available for the Purchaser or his representative.

APPENDIX B
SPECIFICATION DATA SHEET
SUBMERGED-ARC-WELDED STEEL PIPE

PROJECT: _____

PURCHASER: _____

A. PIPE REQUIREMENTS:

Item No.	O.D. (in.)	W.T. (in.)	Grade	Product Specification Level (PSL)	Pipe Test Temperature (˚F)	Manufacturing Method

B. APPLICABLE SPECIFICATIONS:

(i) API 5L, Specification for Line Pipe, 43rd Edition
(ii)

C. FLUID: Analysis attached

D. MIN./MAX. OPERATING TEMPERATURE (°F) _____

E. MAXIMUM FIELD TEST PRESSURE: _____

F. FIELD TEST MEDIUM: _____

G. FIELD TEST DURATION: _____

H. LENGTH REQUIREMENTS:

Item #	Nominal Length (ft.)	Specified lengths in entire shipment (ft.)		
		Minimum any Section	Maximum any Section	Minimum average

NOTES: _____

_____

I. SUPPLEMENTARY REQUIREMENTS:

1. **PIPE BODY ABSORBED ENERGY (ft-lb):**_____
2. **PIPE BODY FRACTURE APPEARANCE (% Shear)**_____
3. **WELD ABSORBED ENERGY (Longitudinal Seam) (ft-lb):**_____
4. **HEAT AFFECTED ZONE ABSORBED ENERGY (Longitudinal Seam)(ft-lb):**_____
5. **WELD ABSORBED ENERGY (Helical, Skelp End, Circumferential Welds) (ft-lb):**_____
6. **HEAT AFFECTED ZONE ABSORBED ENERGY (Helical, Skelp-end, Circumferential Welds) (ft-lb):**_____
7. **REQUIREMENTS FOR END PREPARATION:**_____
8. **REQUIREMENTS FOR EXTERNAL WELD FLUSH-OFF:**_____
9. **MARKING REQUIREMENTS:**_____
10. **COATING:**_____
11. **PLANT INSPECTION BY PURCHASER:**_____
12. **OTHER:**_____

Initiated by:_____	**Date:**_____
Reviewed by:_____	**Date:**_____
Approved by:_____	**Date:**_____

EXHIBIT C.b.2

Enbridge Specifications EES105-2006

Steel Valve Specification

EES105 - 2006

Version: 0
Issue Date: March 24, 2006
Prepared By: Jack Broyles

Table of Contents

1 Scope

This Specification covers requirements for the manufacture, inspection, testing and shipment of gate, plug, ball and check valves intended for use in crude oil, petroleum product, and natural gas liquid pipeline systems. The pipeline systems are designed and constructed in accordance with:

Canada:

i. National Energy Board, Onshore Pipeline Regulations

ii. CSA Z662 Oil and Gas Pipeline Systems

United States:

i. Code of Federal Regulations, Title 49, Volume 3, Part 195 – Transportation of Hazardous Liquids by Pipeline

ii. ASME B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids

This Specification covers valves in sizes from NPS 2 to NPS 60, inclusive.

Nominal pressure classes covered include:

Class Designation	
CSA	**ASME**
PN 20	150
PN 50	300
PN 68	400
PN 100	600
PN 150	900

2 Intent

This specification embodies the required information of industry standards *API 6D* and *CSA Z245.15* as well as Enbridge requirements.

The Application Datasheet shall be completed by the Owner or the Owner's Engineer.

Any and all deviations from this specification shall be brought to the attention of the Owner in writing for resolution prior to final acceptance. All design documentation shall be submitted for approval in a retrievable and reproducible format.

3 Terms, Definitions

For the purposes of this specification, the following terms and definitions apply:

ANSI Rating Class: Numerical pressure design class defined in *ASME B16.5* and used for reference purposes. *NOTE: The ANSI rating class is designated by the word "Class" followed by a number.*

Bi-Directional Valve: Valve designed for blocking the fluid in both downstream and upstream directions.

Bleed: Drain or vent.

Block Valve: Gate, plug or ball valve that blocks flow into the downstream conduit when in the closed position. NOTE: Valves are single- or double-seated, bi-directional or uni-directional.

Breakaway Thrust and Breakaway Torque: Thrust or torque required for opening a valve with maximum pressure differential.

By Agreement: Agreed between manufacturer and Enbridge purchaser.

Double-Block-and-Bleed (DBB) Valve: Valve with two seating surfaces, which, in the closed position, blocks flow from both valve ends when the cavity between the seating surfaces is vented through a bleed connection provided on the body cavity.

Drive Train: All parts of a valve drive between the operator and the obturator, including the obturator but excluding the operator.

Flow Coefficient: Kv – Volumetric flow rate, in cubic meters per hour, of water at a temperature between 5°C (40°F) and 40°C (104°F) passing through a valve and resulting in a pressure loss of 1 bar (14.7 psi). *NOTE: Kv relates to the flow coefficient Cv in US gallons per minute at 15.6°C (60°F) resulting in a 1-psi pressure drop as follows:*

$$Kv=Cv/1156$$

Full-Opening Valve: Valve that opens to the full diameter of the pipe to which it attached to allow unobstructed flow through the line.

Full Round Port Valve: Valve that opens to the full diameter of the pipe to which it attached to allow unobstructed flow through the line.

Handwheel: Wheel consisting of a rim connected to a hub, for example, by spokes, and used to operate manually a valve requiring multiple turns.

Locking Device: Part or an arrangement of parts for securing a valve in the open and/or closed position.

Manual Actuator:

Manual Operator: Wrench (lever) or handwheel with or without a gearbox.

Maximum Pressure Differential (MPD): Maximum difference between the upstream and downstream pressure across the obturator at which the obturator may be operated.

Nominal Pipe Size (NPS): Numerical inches designation of size, which is common to components in piping systems of any one size. *NOTE: the letters NPS followed by a number designates the nominal pipe size.*

Nominal Pressure (PN) Class: Numerical pressure design class as defined in ISO 7005-1 and used for reference purposes. *NOTE the nominal pressure (PN) class is designated by the abbreviation PN followed by a number.*

Nominal Size (DN): Numerical metric designation of size, which is common to components in piping systems of any one size. *NOTE: Nominal size is designated by the letters DN followed by a number.*

Obturator / Closure Member: Part of a valve, such as a ball, clapper, disc, gate or plug, which is positioned in the flow stream to permit or block flow.

Operator: Device (or assembly) for opening or closing a valve.

Position Indicator: Device to show the position of the valve obturator.

Powered Actuator and Operator: Electric, hydraulic or pneumatic device bolted or otherwise attached to the valve for powered opening and closing of the valve.

Pressure Class: Numerical pressure design class expressed in accordance with either the nominal pressure (PN) class or the ANSI rating class. *NOTE: In this Standard, the pressure class is stated by the PN class followed by the ANSI rating class between brackets.*

Pressure-Containing Parts: Parts, such as bodies, bonnets, glands, stems, gaskets and bolting, designed to contain the pipeline fluid.

Pressure-Controlling Parts: Parts, such as seat and obturator, intended to block or permit the flow of fluids.

Process-Wetted Parts: Parts exposed directly to the pipeline fluid.

Reduced-Opening Valve: Valve with the opening through the obturator smaller than at the end connection(s).

Seating Surfaces: Contact surfaces of the obturator and seat, which ensure valve sealing.

Stem: Part that connects the obturator to the operator and which may consist of one or more components.

Stem Extension Assembly: Assembly consisting of the stem extension and the stem extension housing.

Support Ribs or Legs: Metal structure, which provides a stable footing when the valve is set on a fixed base.

Through-Conduit Valve: Valve with an unobstructed and continuous cylindrical opening.

Twin-Seat, Both Seats Bi-Directional, Valve: Valve with two seats, each sealing in both directions.

Twin-Seat, One Seat Uni-Directional And One Seat Bi-Directional, Valve: Valve with two seats, one sealing in one direction and the other in either direction.

Uni-Directional Valve: Valve designed for blocking the flow in one direction only.

Venturi Plug Valve: Valve with a substantially reduced opening through the plug and a smooth transition from each full-opening end to the reduced opening.

4 Symbols and Abbreviations

4.1 Symbols

C_v Flow coefficient in Imperial units.

K_v Flow coefficient in Metric units.

4.2 Abbreviations

BM	Base Metal
CE	Carbon Equivalent

DBB	Double-Block-and-Bleed
DN	Nominal Size
HAZ	Heat-Affected Zone
HR	Rockwell Hardness
HV	Vickers Hardness
MPD	Maximum Pressure Differential
MT	Magnetic-Particle Testing
NDE	Non-Destructive Examination
NPS	Nominal Pipe Size
PN	Nominal Pressure
PQR	Procedure Qualification Record
PT	Penetrant Testing
PWHT	Post-Weld Heat Treatment
SMYS	Specified Minimum Yield Strength
WM	Weld Metal
WPS	Weld Procedure Specification
WQR	Welder Qualification Record

5 Valve Types

5.1 Valve Types

Valves shall adhere to one of the following types and where applicable it shall also be designated either Full Port (FP) or Reduced Port (RP):

5.2 Gate Valves

Style 1: Single Slab Rising Stem

Style 2: Multi Piece Expanding Gate

Gate valves are to be used for fully opened or fully closed position only.

Multi piece gate valves shall be installed only in the up right position, and shall be used where temperature fluctuations may vary substantially beyond design atmospheric conditions.

Gate valves shall be provided with a back seat or secondary stem-sealing feature in addition to the primary stem seal.

Wedge gate valves shall have an internal wedge guide to prevent chatter and seat damage.

5.3 Plug Valves

Style 1: Non-Lubricated

Style 2: Lubricated

Plug valves shall have a cylindrical or conical obturator, which rotates about an axis perpendicular to the direction of flow.

Plug valves shall be short pattern type.

5.4 Ball Valves

Style 1: Top Entry Floating

Style 2: Three-Piece

Style 3: Welded Body

Ball valves shall have a spherical obturator, which rotates on an axis perpendicular to the direction of flow.

Ball valves 12” and larger shall be trunnion mounted.

5.5 Check Valves

Style 1: Reduced Opening Swing

Style 2: Full Opening Swing

Style 3: Dual Plate Wafer

Style 4: Single Plate Wafer

Check valves shall have an obturator, which responds automatically to block fluid in one direction.

5.6 Full-Opening Valves or Full Port Valves

Full-opening valves shall be unobstructed in the fully opened position and have an internal bore as specified in *Table A1.1, Appendix I*. There is no restriction on the upper limit of valve bore sizes.

Full-opening through-conduit valves shall have a circular bore in the obturator that will allow a sphere to pass. The bore diameter of the valve shall not be less than specified in *Table A1.1, Appendix I.*

Welding-end valves may require a smaller bore at the welding end to mate with the pipe.

5.7 Reduced-Opening Valves or Reduced Port Valves

The internal bore of reduced-opening or reduced port valves shall be less than the internal bore specified in *Table A1.1, Appendix 1*.

6 Design

6.1 Pressure and Temperature Rating

The nominal pressure (PN) class required is identified on the Application Datasheet.

Pressure classes shall be specified in accordance with the applicable rating tables for material groups in *ASME B16.34.*

The pressure and temperature ratings for metal (or equivalent) seats of ball valves, seated check valves shall be the same as for the flanges and shell.

The maximum operating pressure at the minimum and maximum operating temperatures shall be marked on the nameplate.

6.2 Sizes

All valves, except for reduced-opening valves, shall be furnished in the nominal sizes (DN) listed in *Tables A1.2 to A1.6, Appendix I*.

Reduced-opening valves shall be furnished in the nominal sizes in accordance with *Table A1.1, Appendix I.*

Reduced-opening valves with a circular opening through the obturator shall be specified by the nominal size of the end connections and the nominal size of the minimum bore of the obturator in accordance with *Table A.1, Appendix I*, except that for valve sizes DN 50 (NPS 2) or smaller the actual bore of the obturator shall be specified.

Reduced-opening valves with a non-circular opening through the obturator and reduced-opening check valves shall be designated as reduced-bore valves and specified by the nominal size corresponding to the end connections followed by the letter "R".

6.3 Face-to-Face and End-to-End Dimensions

Face-to-face and end-to-end dimensions of valves shall be in accordance with *Tables A1.2 to A1.6, Appendix I.*

The length of valves having one welding end and one flanged end shall be determined by adding half the length of a flanged-end valve to half the length of a welding-end valve.

Tolerances on the face-to-face and end-to-end dimensions shall be ± 2 mm for valve sizes DN 250 and smaller, and ±3 mm for valve sizes DN 300 and larger.

6.4 Minimum-Bore Full-Opening Valves

Minimum bores for full-opening valves shall not be less than those specified in *Table A1.1, Appendix I.*

6.5 Valve Operation

The maximum pressure differential (MPD) at which the valve is required to be opened by the lever, gearbox or actuator is indicated on the Application Datasheet.

The pressure rating as determined in accordance with *Clause 6.1* for material at 38°C (100°F) shall be the MPD, unless otherwise specified.

6.6 Pigging

Valves that will be subjected to pigging shall be identified on the Application Datasheet.

6.7 Valve Ends

6.7.1 Flanged Ends

Standard end flanges shall be furnished with a raised face or ring joint faces (raised face or full face). Dimensions, tolerances and finishes, including drilling templates, flange facing, spot facing and back facing, shall be in accordance with:

a) *ASME B16.5* Steel Pipe Flanges and Flanged Fittings (up to 24 inch).

b) *ASME B16.47* Large Diameter Steel Flanges (formally *MSS SP-44*) (over 24 inch).

6.7.2 Welded Ends

Standard details for welded ends are illustrated in *Appendix V.*

Welding ends shall conform to *Figures A5.1-1 and A5.1-2, Appendix V*. In the case of a heavy-wall valve body, the outside profile may be tapered at 30° and then to 45° as illustrated in *Figure A5.2, Appendix V*.

The outside diameter, wall thickness, material grade, SMYS and special chemistry of the mating pipe, and whether cladding shall be specified in the Application Datasheet.

6.7.3 Special Flanges and Mechanical Joints

Special flanges and mechanical joints are not permitted.

6.8 Pressure Relief

The manufacturer shall determine whether fluid can become trapped in the body cavity in the open- and/or closed-valve position.

If fluid trapping is possible, then the manufacturer shall provide the valve with a means to prevent overpressure or a means to relief pressure such as automatic cavity pressure relief. The pressure relief line shall be connected to the non-isolated portion of the valve body. Relief to atmosphere is not acceptable.

Cavity relief, when required, shall prevent the pressure in the cavity from exceeding 1.33 times the valve pressure rating determined in accordance with *Clause 6.1* for material at 38°C (100°F). External cavity relief valves shall be DN 15 (NPS 1/2) or larger.

6.9 Bypass and Drain Connections

Bypass or drain connections lines shall be identified on the Application Datasheet when required. Unless specified otherwise, bypass lines shall be 1/2” 304 Stainless steel tubing. Swagelok valves, tubing and fittings are preferred.

Valves for below grade service require drain lines to be routed to the top of the valve. For below grade valves, the bottom ½ in. NPT drain shall be piped to 450 mm (18 in.) above grade. The piping is to be capped with a ½ in. ball valve and plug.

Valves for above grade service shall be supplied with a removable drain plug. Drain plug threads shall be either tapered and capable of providing a pressure-tight seal or parallel-

threaded. Connections or plugs with parallel threads shall have a head section for trapping and retaining, a sealing member suitable for the specified valve service.

Thread forms shall be in accordance with *ISO 228-1.*

If specified on the Application Datasheet, the Vendor shall supply a double block and bleed port and valve for double seated valves. Bleed valves shall be of bolted or one-piece construction to guard against accidental disassembly.

6.10 Handwheels and Wrenches (Levers)

Wrenches for valves shall be an integral design or consist of a head, which fits on the stem and is designed to take an extended handle. The head design shall allow permanent attachment of the extended section if specified on the Application Datasheet.

The maximum force required at the handwheel or wrench to apply the breakaway torque or thrust shall not exceed 360 N (80 lbf). The manufacture shall provide a gear operator when this value is exceeded.

Wrenches shall not be longer than twice the face-to-face or end-to-end dimension of the valve.

Handwheel diameter shall not exceed the face-to-face or end-to-end length of the valve or 1000 mm, whichever is the smaller. Except for valve sizes DN 40 (NPS 1 1/2) and smaller, spokes shall not extend beyond the perimeter of the handwheel.

The handwheel of the gearbox input shaft shall be provided with a torque-limiting device, such as a shear pin, to prevent damage to the drive train.

The gear and motorized operators shall be designed to operate against the maximum differential pressure.

6.11 Position Indicators

Valves fitted with manual or powered actuators shall be furnished with a visible indicator to show the open and the closed position of the obturator.

For plug and ball valves, the wrench and/or the position indicator shall be in line with the pipeline when the valve is open and transverse when the valve is closed. The design shall be such that the component(s) of the indicator and/or wrench cannot be assembled to falsely indicate the valve position.

Valves without position stops shall have provision for the verification of open and close alignment with the operator/actuator removed.

6.11.1 Operators and Stem Extensions

6.11.2 Stem Extensions

Valves that require stem extensions will be indicated on the Application Datasheet with the length. The reference points for length shall be valve opening centreline to the face of the gear/activator mounting flange. Stems shall be constructed of one piece.

The Application Datasheet will indicate the dimension between centreline of the valve opening and the centreline of the handwheel. For electric motor operated valves, the valve Vendor shall

supply the dimensional details for review with the actuator vendor to ensure the desired extension dimensions are met.

Extended stem assemblies shall be strengthened as required to withstand the additional loading. All flanged, bolted, or machined surfaces on stem extensions shall have gaskets or have O-rings on mating surfaces to prevent water ingress into the valve stems.

The dimension of centreline of valve opening to top of grade (or platform) is specified on the Application Datasheet.

Extensions and valve yoke tubes shall be fitted with top and bottom ½ in. NPT drain fittings so that seals can be checked for leakage and water can be drained.

6.11.3 Misalignment

Misalignment or improper assembly of components shall be prevented by suitable means, such as a dowel pin or fitting bolt, which ensure the unique location of manual or powered operators and stem extension assemblies. Intermediate shaft guides shall be installed on extensions greater than 2500 mm (8 ft) in length.

6.11.4 Sealing

External connections shall be sealed, for example with gaskets or O-rings, to prevent external contaminants entering the mechanism.

6.11.5 Overpressure Protection

Operators and stem extension assemblies shall be provided with a means of preventing pressure build-up in the mechanism resulting from stem or bonnet seal leakage.

6.12 Valve Seat Lubrication

All valves shall be non-lubricated for normal valve seating.

Seat and/or stem sealant injection shall be provided when specified on the Application Datasheet. The valves shall be equipped with the provision for external lubricant injection to extend service life and provide emergency sealing, in case of worn seals. All grease fittings shall be “Flo-Wolf” or equal.

6.13 Lifting Lugs

Valves of size DN 200 (NPS 8) and larger shall be provided with lifting lugs.

6.14 Manual Actuator Provisions

The type of operator required is specified on the Application Datasheet.

Handwheel or wrench actuators shall have a maximum rim pull of 35 kg (80 lb). A clockwise rotation of the handwheel shall close the valve. An arrow indicating the direction of rotation to close the valve shall be permanently engraved on the handwheel.

6.15 Powered Actuator Provisions

Valves to be operated by powered actuators are specified on the Application Datasheet.

The interface between actuators and valve bonnet or stem extension assemblies shall be designed to prevent misalignment or improper assembly of the components. Fabrication drawings of the valve–actuator interface plate and stem connection details shall be provided with the valve at time of purchase.

Valves that are to be fitted with actuators by others shall be supplied with stem only and an actuator-mounting bracket installed.

The interface between actuators and valve bonnet or stem extension assemblies shall be sealed with gaskets or O-rings to prevent external contaminants from entering the assembly.

Means shall be provided of preventing pressure build-up in the actuator from stem or bonnet seal leakage.

The output of the actuator shall not exceed the maximum load capacity of the valve drive train.

Unless stated otherwise on the Application Datasheet, for electrically operated valves, the electric motor operator shall be supplied and installed by others.

6.16 Drive Trains

6.16.1 Design Thrust or Torque

The design thrust or torque for all drive train calculations shall be at least two times the breakaway thrust or torque.

Gears and bearings of the gearbox shall be weather, dust proof filled with suitable grease for -45ºC, and fully enclosed.

NOTE: This factor of safety is to allow for thrust or torque increase in service due to infrequent cycling, low-temperature operation and the adverse effect of debris.

6.16.2 Allowable Stresses

Tensile stresses in drive train components, including stem extensions, shall not exceed 67% of SMYS when delivering the design thrust or torque. The maximum design von Mises stress (combined bending, shear, torsion and bearing stresses) shall not exceed the 1/2 of the yield stress of the material for any component under any anticipated load.

A strength efficiency factor of 0.75 shall be used for fillet welds.

6.16.3 Allowable Deflections

For ball valves, the total torsional deflection of the extended drive train when delivering the design torque shall not exceed the overlap contact angle between the seat and obturator.

Deflections of the extended drive train shall not prevent the obturator from reaching the fully closed position.

6.17 Stem Retention

Valves shall be designed with a stem anti-blow-out device to prevent stem ejection by internal pressure when the stem packing and/or retainer has been removed.

7 Materials

The materials of construction shall include but not be limited to the following:

a) Valve body and pressure containment components;

b) Bonnet;

c) Shaft material;

d) Bolts and nuts;

e) Seals.

7.1 Material Specification

Materials of construction shall be as specified in this section. Manufacturers shall submit positive identification certificates in the form of a certified Material Test Report (MTR) for all pressure containing and process wetted components. The minimum information to be provided shall be:

a) Chemical properties;

b) Heat treatment;

c) Mechanical properties;

d) Test results;

e) Manufacturers Certification.

One or a combination of the following material specifications is anticipated for most applications (oil at typical Enbridge pipeline specifications). Alternate material may be proposed provided it is clearly identified by the manufacture and accepted by Enbridge and as required to meet the project specific requirements as indicated on the Application Datasheet. The temperatures shown are the minimum permitted per material specification, impact tested where applicable. For design temperatures below these values, impact testing for notch toughness is required.

Material Specification	Product Form	Minimum Temperature
ASTM A 216 Gr. WCB	Carbon Steel casting	-20 °F
ASTM A 216 Gr. WCC	Carbon Steel casting	-20 °F
ASTM A 217 Gr. WC6	¼ Cr – ½ Mo casting	-20 °F
ASTM A 217 Gr. C5	5 Cr – ½ Mo casting	-20 °F
ASTM A 217 Gr. WC9	2¼ Cr – ½ Mo casting	-20 °F
ASTM A 351 Gr. CF8M	18 Cr-10 Ni-2 Mo (alt. Low temp.)	-425 °F
ASTM A 352 Gr. LCB	C-½ Mo casting	-50 °F
ASTM A 352 Gr. LCC	C-½ Mo casting	-50 °F
ASTM A105	Carbon Steel forging	-20 °F
ASTM A181 Cl. 60	Carbon Steel forging	-20 °F
ASTM A181 Cl. 70	Carbon Steel forging	-20 °F
ASTM A182 F11	¼ Cr. - ½ Mo forging	-20 °F
ASTM A182 F22	2¼ Cr. - 1 Mo forging	-20 °F
ASTM A182 F6	13 Cr. Alloy forging	-20 °F
ASTM A350 LF 2	Carbon steel forging	-50 °F
ASTM A537 Cl 1&2	Carbon steel plate	-20 F
ASTM A333 Gr. 6	Carbon steel pipe	-50 F

Table 7.1 Material Specifications

One or a combination of the following material specifications shall be used for valve trim material.

Trim Number	Stem	Body Seat	Obturator Seat	Back Seat
1	13% Cr.	CS+13% Cr.	CS+13% Cr	13% Cr
5	13% Cr	CS+Stellite 6	CS+13% Cr	13% Cr
8	13% Cr	CS+Stellite 6	CS+Stellite 6	18% Cr
12	SS316	CS+Stellite 6	CS+ SS 316	SS 316

Table 7.2 Trim Material Specifications

7.2 Gate and Globe Valves

Manufacturer may substitute ASTM A217 Gr. CA15 or A 351 Gr. CF8M material for wedge or globe base material.

For additional materials consult ASME B16.34 or Table 2 of CSA Z245.15, depending on location of installation. Alternate approved materials shall be noted on the Valve Datasheet completed by the manufacturer.

7.3 Gaskets and O-Rings

The metallic portion exposed to the service environment shall be of a material that has a corrosion resistance at least equal to that of the body material.

Inside diameter mating gaskets shall not be smaller than the inside diameter of the flanges.

Gasket or O-ring material shall have a duorometer number of 70 to 90. Acceptable materials, depending upon service conditions, are:

a) Kalrez® (-40° to 600° F);

b) Nitrile (Buna-N) (-40° to 275° F);

c) Highly Saturated Nitrile HSN (-40° to 350° F);

d) Viton® (Fluorocarbon) (-20° to 400° F);

e) Braided PTFE graphite.

Manufacturer shall confirm suitability of sealing material for service. Manufacturer shall also confirm suitability of sealing material for field hydrotesting with methanol and or glycol mixes.

7.4 Stem and Stem Nut

The stem shall be designed to accept the maximum torque required to open or close the valve under pressure without excessive deflection.

Stem material shall be selected *per Clause 7.1*. In certain applications, carbon steel stems with 3 mils of electroless nickel plating may be offered as an alternative, subject to the Company's approval.

See also *Clause 6.17.1* for torsion requirements.

Valve stem nuts used to engage gear drive mechanisms shall be of bronze or aluminium-bronze alloy material.

7.5 Valve Ends

Flanged valves shall have raised face flanges with dimensions and tolerances in accordance with the requirements of ASME B16.5 or MSS SP-44-1996.

Welded ends shall be beveled to accommodate a butt weld connection to pipe in accordance with the manufacturing specification. The specifics of the matching pipe are provided on the Application Datasheet.

The Vendor shall indicate whether pipe transition pieces would be required to accommodate the butt weld to the matching pipe. Valves ends made of cast materials shall have transition pieces supplied and installed by the Vendor to accommodate the butt weld to matching pipe.

In some cases, the Company will require transition pieces and will specify this on the Application Datasheet. If transition pieces are required, the Company and Vendor shall agree on the supply of materials and the design of the end connection.

7.6 Service Compatibility

All process-wetted parts, metallic and non-metallic, and lubricants shall be suitable for the commissioning fluids and service specified by on the Application Datasheet.

The description and properties of the fluid handled, including minimum and maximum temperature, specific gravity, viscosity, etc shall be provided to the manufacturer prior to valve fabrication.

The manufacturer shall consider all of the data in the Valve Datasheet when selecting the appropriate materials of manufacture for the valve. Asbestos and asbestos compounds shall not be used.

7.7 Forged Parts

Forged pressure containing parts shall be forged close to the finished shape and size.

7.8 Welding Ends

7.8.1 For Welded End Valves

The chemistry of carbon steel welding ends shall meet the following requirements:

a) The carbon content shall not exceed 0.23% by mass in the ladle (heat) analysis or 0.25% by mass in the product (check) analysis;

b) The maximum content of both sulfur and phosphorus shall not exceed 0.035% by mass;

c) The carbon equivalent (CE) shall not exceed 0.43 in the ladle (heat) analysis or 0.45 in the product (check) analysis. The CE shall be calculated in accordance with the following formula:

$$CE = \%C + (\% Mn/6) + (\% Cr + \% Mo + \% V)/5 + (\% Ni + \% Cu)/15$$

The chemistry of austenitic stainless steels for welding ends shall meet the following requirements:

a) The carbon content shall not exceed 0.03% by mass, except under the conditions outlined in b) and c) below;

b) A carbon content of up to 0.08% by mass is permissible provided the material is stabilized with niobium and the niobium content is at least 10 times the carbon content by mass;

c) For steels stabilized with niobium or tantalum, the combined mass of niobium and tantalum shall be at least eight times the mass of the carbon. Requirements for the chemistry of welding ends made of other materials shall be established by agreement.

7.9 Toughness Test Requirements – Materials

Manufacturer to provide the results of impact testing when the minimum service temperature is below -29°C.

All carbon and low-alloy steels for pressure-containing parts in valves with a specified design temperature below -29°C (-20°F) shall be impact-tested using the Charpy V-notch technique in accordance with *ISO 148 or ASTM A 370.*

Materials shall be procured to documented specifications.

Toughness testing may be performed during the qualification of the valve manufacturing procedure provided that the material for testing is heat-treated using the same equipment as during valve production.

The impact test temperature shall be as defined in the Application Datasheet for minimum temperature.

Except for material for bolting, impact test results for full-size specimens shall meet the requirements of *Table 7.3* Impact test results for bolting material shall meet the requirements of *ASTM A 320*.

Average of Three Specimens (MPa)	**Average of Three Specimens** (J)	**Minimum for Single Specimen** (J)
≤ 586	20	16
587 - 688	27	20
≥ 689	34	25

Table 7.3 Charpy V-Notch Impact Requirements (Full-Size Specimen)

7.10 Bolting

Bolting shall be suitable for the specified valve service and pressure rating.

ASTM Specifications:

a) Bolts A 193 Gr. B7, or A 320 Gr. L7 (low temp)

b) Nuts A 194 Gr. 2H, or A 194 Gr. 4 (low temp)

8 Welding

8.1 Qualifications

Welding, including repair welding, of pressure - containing and pressure-controlling parts shall be performed in accordance with procedures qualified to *ASME Section IX or EN 288-3*, and *Clauses 9.2 and 9.3* of this specification. Welders and welding operators shall be qualified in accordance with *ASME Section IX or EN 287-1*.

The Vendor shall notify the Company when a repair has been made to a valve.

The manufacturer shall provide an adequate quality control of welding and welding repair.

The results of all qualification tests shall be documented in a procedure qualification record (PQR). Post-weld heat treatment (PWHT) shall be performed in accordance with the relevant material specification.

8.2 Impact Testing – Welding

Impact testing shall be carried out for the qualification of procedures for welding on valves with a design temperature below -29°C (-20°F). Where required impact testing temperature shall be -45°C, lower temperatures may be specified on the Application Datasheet.

NOTE: Design code and/or local requirements may require impact testing at minimum design temperatures above -29°C (-20°F).

A set of three weld metal impact specimens shall be taken from the weld metal (WM) at the location shown in *Figure A6.3, Appendix IV*. The specimens shall be oriented with the notch perpendicular to the surface of the material.

A set of three impact specimens shall be taken from the heat-affected zone (HAZ) at the location shown in *Figure A6.4, Appendix IV*. The notch shall be placed perpendicularly to the material surface at a location resulting in a maximum amount of HAZ material located in the resulting fracture.

HAZ tests shall be conducted for each of the materials being joined when the base materials being joined are of a different P-number and/or group number in accordance with *ASME Section IX* or when one or both of the base materials being joined are not listed in the P-number grouping.

Impact testing shall be performed in accordance with *ISO 148 or ASTM A 370* using the Charpy V-notch technique. Specimens shall be etched to determine the location of the notch.

The impact test temperature for welds and heat-affected zones shall be at or below the minimum design temperature specified for the valve.

Impact test results for full-size specimens shall meet the requirements of *Table 7.3*, Hardness testing. Hardness surveys shall be performed on base metal (BM), WM and HAZ as indicated in *Appendix IV* using the Rockwell HRC or Vickers HV10 method.

9 Painting/Coating

9.1 Coating

Valves for below grade service shall be coated. Vendor shall provide the coating procedure with his bid submission for approval by Enbridge. If the procedure is not approved, then the vendor shall coat the valve using Enbridge's "C-110 Coating of Buried Steel with Plural Component Spray Applied Coatings" procedure.

9.2 Painting

Valves for above grade service shall be painted. The Vendor shall provide the painting procedure with his bid submission for Enbridge approval. If the procedure is not approved, then the Vendor shall paint the valve using Enbridge's "P-210 Shop and Field Painting" procedure.

10 Quality Control

10.1 Non-Destructive Testing

Manufacturers that are certified holders of a current API Monogram license, supplying monogrammed product need only submit a copy of the license, and contact name of the responsible shop inspector.

All other Manufacturers shall supply a copy of their Quality Test plan verifying NDE requirements are met and that they are in accordance with the material specification for review and acceptance. Non-Destructive testing shall be conducted to the extent necessary to detect

all defects in the manufactured piece or pieces and to determine compliance with dimensional requirements. The Manufacturer shall clearly indicate which procedures (Radiographic, Ultrasonic, Magnetic particle, Liquid Penetrant) are used and to what extent. Acceptable procedures are given in *Table 10.1* below.

One or several of the follow methods shall be utilized for Non Destructive testing of the valve components:

Manufactured Component	Examination	Exam Procedure	Acceptance Criteria
Weldments – all pressure boundary welds require 100% examination	Radiographic	ASME V, Article 22	ASME VIII, Div. 1 Part UW51 for linear indications and Appendix 4 for rounded indications
	Ultrasonic	ASME V, Article 23	ASME VIII, Div. 1, Appendix 12
Castings	Radiographic	ASME V, Article 22	ASME VIII, Div. 1, Appendix 7
Castings	Ultrasonic	ASME V, Article 23	ASTM A 609, Table 2, Quality Level 1
Castings	Magnetic Particle	ASME V, Article 25	ASME VIII, Div. 1, Appendix 6
Castings	Liquid Penetrant	ASME V, Article 24	ASME VIII, Div. 1, Appendix 8
Forgings	Ultrasonic	ASTM A 388	ASTM A 388
Forgings	Magnetic Particle	ASME V, Article 25	ASME VIII, Div. 1, Appendix 6
Plates (as applicable)	Ultrasonic	ASTM A 435 or A 577	ASTM A 435 or A 577

Table 10.1 Non Destructive Testing Requirements

10.2 Non-Destructive Test Records

All radiographs shall be identified and shall be available for the Company representative to view. A written record of all non-destructive examinations required by this Specification and the results shall be submitted to the Company upon completion of the order.

10.3 Measuring and Test Equipment

10.3.1 General

Equipment used to inspect, test or examine material or equipment shall be identified, controlled and calibrated at intervals specified in the manufacturer's instructions.

10.3.2 Dimension-Measuring Equipment

Equipment for measuring dimensions shall be controlled and calibrated in accordance with methods specified in documented procedures.

10.3.3 Pressure-Measuring Devices

10.3.4 Type and Accuracy

Test pressure measuring devices shall be either pressure gauges or pressure transducers, which are accurate to within ± 2.0% of the full-scale reading.

10.3.5 Gauge Range

Pressure measurements shall be made between 25% and 75% of the full pressure range of the measuring device.

10.3.6 Calibration Procedure

Pressure-measuring devices shall be periodically recalibrated with a master pressure-measuring device or a deadweight tester at 25%, 50%, 75% and 100% of the full pressure scale.

10.3.7 Temperature-Measuring Devices

Devices for measuring temperature, if required, shall be capable of indicating and recording temperature fluctuations of 3°C (5°F).

10.4 Qualification of Inspection and Test Personnel

10.4.1 NDE Personnel

NDE personnel shall be qualified in accordance with the requirements specified in ASNT SNT-TC-1A or EN 473 Level II as a minimum.

Personnel performing visual examinations shall have passed an annual eye examination in accordance with ASNT SNT-TC-1A or EN 473 within the previous twelve months.

10.4.2 Welding Inspectors

Personnel performing visual inspection of welding operations and completed welds shall be qualified and certified to the requirements of AWS QC1, or equivalent, or a manufacturer's documented training program.

10.5 NDE of Repair Welding

After defect removal, the excavated area shall be examined by magnetic particle (MT) or liquid penetrant (PT) methods prior to starting repair welding.

Repair welds on pressure-containing parts shall be examined using MT or PT methods. Acceptance criteria shall be specified in documented procedures.

10.6 Shop Inspection

The Company may have a Company Inspector present in the Vendor’s manufacturing facility at any time during the manufacture of the valves. The Company Inspector may witness all

hydrostatic tests and may be present for other tests and NDE. The Company Inspector may also witness the final inspection of each valve prior to shipment to ensure the valves meet all requirements of this Specification and the purchase order.

The Company shall be notified of any injurious defects found on any pressure containing valve component during non-destructive tests.

11 Pressure Testing

11.1 General

Each valve shall be tested in accordance with this clause prior to shipment. Testing shall be performed in the sequence used in this clause for specifying the test requirements. Shell pressure testing shall be carried out before painting of the valves. Test fluids shall be fresh water, which may contain corrosion inhibitors. The chloride content of test water for austenitic and ferritic-austenitic (duplex) stainless-steel body/bonnet valves shall not exceed 30 ppm.

Valves shall be tested with the seating and sealing surfaces free from sealant except where the sealant is the primary means of sealing.

Tests specified with the valve half-open may also be performed with the valve fully open provided the body cavity is simultaneously filled and pressurized through a cavity connection.

Methods for monitoring pressures and/or leakage shall be adequate also when valve body connections are not available for direct monitoring. The leak test shall be performed at both the minimum and maximum operating temperatures. A sufficient stabilization period shall be allowed for all pressure tests. Test shall be witnessed by Enbridge or designate. Pressure testing shall be performed in accordance with documented procedures.

11.2 Stem Backseat Test

Stem backseat testing shall be performed prior to shell testing. Where a valve has a stem backseat feature, testing of the backseat shall commence with the seat free. Self-energized packing or seals shall be removed unless a test port is provided for this test.

The valves shall be filled with the ends closed off and the obturator in the partially open position until leakage of the test fluid around the stem is observed. The backseat shall then be closed and a minimum pressure of 1.1 times the pressure rating determined in accordance with *Clause 6.1* for material at 38°C (100°F) is applied for the duration specified in *Table 11.1*.

Monitoring for leakage shall be through a test access port or by monitoring leakage around the loosened packing.

No visible leakage is permitted at this test pressure.

Valve Size		Test Duration (minutes)
DN (mm)	NPS (inches)	
≤ 00	≤ 4	2
≥ 50	≥ 6	5

Table 11.1 Minimum Duration of Stem Backseat Tests

11.3 Hydrostatic Shell Test

Hydrostatic shell testing shall be performed on the fully assembled valve prior to painting or coating.

Valves shall be closed off and the obturator placed in the partially open position during the test. The method of closing the ends shall permit the transmission of the full-pressure force acting on the end blanks to the valve body. Where present, external relief valves shall be removed and their connections plugged.

The test pressure shall be 1.5 or more times the pressure rating determined in accordance with *Clause 6.1* for material at 38°C (100°F). The duration shall not be less than that specified in Table 10.2.

Where the longer test durations are required, these will be indicated on the Application Datasheet.

Valve Size		Test Duration (minutes)
DN (mm)	NPS (inches)	
15 -100	½ - 4	2
150 -250	6 -10	5
300 -450	12 -18	15
500 - 915	20 - 36	30
Over 915	> 36	120

Table 11.2 Minimum Duration of Hydrostatic Shell Tests

The test shall be documented on a chart recorder.

No visible leakage is permitted during the hydrostatic shell test.

After hydrostatic shell testing, external relief valves shall be (re)fitted to the valve. The connection to the valve body shall be tested at 95% of the set pressure of the relief valve for 2 minutes for valve sizes up to and including DN 100 (NPS 4), and 5 minutes for valve sizes DN 150 (NPS 6) and larger. The relief valve connection shall be free of visible-leakage during this period.

Where provided, the external relief valve shall be set to relieve at the specified pressure and tested. The set pressure of relief valves shall be between 1.1 and 1.33 times the valve pressure rating determined in accordance with *Clause 6.1* for material at 38°C (100°F).

11.4 Hydrostatic Seat Test

11.4.1 Preparation

Lubricants shall be removed from seats and obturator sealing surfaces except, by agreement, for assembly lubricants for metal-to-metal contact surfaces.

11.4.2 Test Pressure and Duration

The test pressure for all seat tests shall not be less than 1.1 times the pressure rating determined in accordance with *Clause 6.1* for material at 38°C (100°F). The test duration shall be in accordance with *Table 11.3*.

When longer test durations are required, these will be indicated on the Application Datasheet.

Valve Size		Test Duration (minutes)
DN (mm)	NPS (inches)	
15 -100	½ - 4	2
150 - 915	6 - 36	5
Over 915	> 36	10

Table 11.3 Minimum Duration of Seat Tests

The test shall be documented on a chart recorder.

11.4.3 Acceptance Criteria

Leakage for soft-seated valves and lubricated plug valves shall not exceed ISO 5208 Rate A (no visible leakage). For metal-seated valves the leakage rate shall not exceed ISO 5208 Rate D, except that the leakage rate during the seat test in *Clause 11.4.4.5.2* shall not be more than two times ISO 5208 Rate. The test procedures for various types of block valve are given in *Clause 11.4.4*.

11.4.4 Test Procedures for Block Valves

11.4.5 Uni-Directional

With the valve half-open, the valve and its cavity shall be completely filled with test fluid. The valve shall then be closed and the test pressure applied to the appropriate end of the valve.

Leakage from each seat shall be monitored via the valve body cavity vent or drain connection. For valves without a body cavity connection, seat leakage shall be monitored from each seat at the respective downstream end of the valve (the valve end downstream of the pressurized test fluid).

11.4.6 Bi-Directional

With the valve half-open, the valve and its cavity shall be completely filled with test fluid. The valve shall then be closed and the test pressure applied successively to both ends of the valve.

Seat leakage shall be monitored from each seat via the valve body cavity vent or drain connection. For valves without a body cavity vent or drain connection, seat leakage shall be monitored from the respective downstream end of the valve.

11.4.7 Twin-Seat, Both Seats Bi-Directional

Each seat shall be tested in both directions.

Cavity relief valves shall be removed if fitted. The valve and cavity shall be filled with test fluid, with the valve half-open, until the test fluid overflows through the cavity relief connection.

To test for seat leakage in the direction of the cavity, the valve shall be closed. The test pressure shall be applied successively to each valve end to test each seat separately from the upstream side. Leakage shall be monitored via the valve cavity pressure relief connection.

Thereafter, each seat shall be tested as a downstream seat. Both ends of the valve shall be drained and the valve cavity filled with test fluid. Pressure shall then be applied whilst monitoring leakage through each seat at both ends of the valve.

11.4.8 Twin-Seat, One Seat Uni-Directional and One Seat Bi-Directional

11.4.9 Uni-Directional Seat

With the valve half-open, the valve and the test cavity shall be completely filled with test fluid until fluid overflows though the valve cavity vent connection. The valve shall then be closed and the vent valve on the test closure opened to allow fluid to overflow, or the test closure on the downstream end of the valve removed. The test pressure shall then be applied to the upstream end (uni-directional seat end) and leakage monitored from the cavity connection. If leakage is also occurring through the downstream seat, the upstream seat leakage shall be taken as the sum of the leakage measured from the cavity and the downstream connections.

11.4.10 Bi-Directional Seat

The test in *Clause 10.4.4.4.1* shall be repeated to test the bi-directional seat in its upstream-sealing direction.

To test the bi-directional seat in its downstream-sealing direction, both ends of the valve shall be blanked off. With the valve half-open, the valve shall be completely filled with test fluid and pressurized to the test pressure. The valve shall then be closed and test fluid allowed to overflow from a connection on the test closure fitted to the end of the valve at the bi-directional seat end (i.e., downstream of the bi-directional seat). The test pressure shall be maintained on the cavity connection whilst monitoring seat leakage of the bi-directional seat at the overflow connection on the downstream test closure.

11.4.11 Double-Block-and-Bleed Valves

11.4.12 Single-Seat Test

With the valve half-open, the valve and its cavity shall be completely filled with test fluid. The valve shall then be closed and the valve body vent valve opened to allow excess test fluid to overflow from the valve cavity test connection. The test pressure shall then be applied to one end of the valve and the pressure released at the other end. This test shall be repeated for the other valve end.

Seat tightness shall be monitored during each test via overflow from the valve cavity connection.

11.4.13 Double-Block Seat Test

With the valve half-open, the valve and its cavity shall be completely filled with test fluid. The valve shall then be closed and the valve body vent valve opened to allow excess test fluid to overflow from the valve cavity test connection. The test pressure shall be applied simultaneously from both valve ends.

Seat tightness shall be monitored via overflow through the valve cavity connection.

The tests in *Clause 11.4.4.5* may be performed in any order by the manufacturer.

11.4.14 Check-Valves

The pressure shall be applied in the direction of the required flow blockage.

11.4.15 Installation Of Body Connections After Testing

Pressure-containing parts, such as vent/or drain plugs and cavity relief valves, shall be fitted, on completion of testing.

11.5 Draining

Valves and valve cavities shall be drained of test fluids and, where applicable, lubricated before shipment.

12 Marking Requirements

12.1 Marking

Valves shall be marked in accordance with *Table 12.1*.

On valves whose size or shape limits the body markings, they may be omitted in the following order:

1. Size
2. Rating
3. Material
4. Manufacturer's name or trademark.

Valves shall be marked as per MSS-SP-25 plus:

Each valve shall be fitted with a stainless metal tag of 16 BWG minimum thickness, securely attached with stainless steel wire. Tags shall normally be attached to the yoke. When that is not possible, the tag may be attached to the handwheel or other appropriate location. Tags shall not be attached through bolt holes of end flanges.

These additional metal tags shall have the following information:

a) Enbridge Valve Shipping Tag Number;

b) Purchase order number;

c) Supplier number;

d) Any other markings as stipulated on the purchase order.

The minimum letter size shall be 0.2”.

The nameplate and serial number may be omitted for valves smaller than DN 50 (NPS 2).

For valves with one seat uni-directional and one seat bi-directional only, the directions of both seats shall be specified on a separate identification plate as illustrated in *Figure 12.1*. In *Figure 12.1*, one symbol indicates the bi-directional seat and the other symbol indicates the uni-directional seat.

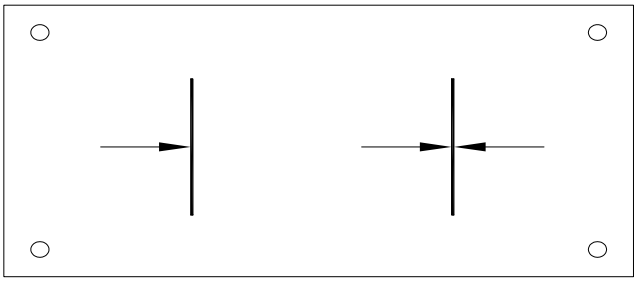


Figure 12.1 Typical Identification Plate for Valve with One Seat Uni-Directional and One Seat Bi-Directional

	Marking	Application
1	Manufacturer's name or trademark	On both body and nameplate
2	Pressure Class	On both body and nameplate
3	Pressure/temperature rating: a) Maximum operating pressure at maximum operating temperature b) Maximum operating pressure at minimum operating temperature	On nameplate
4	Face-to-face/end-to-end dimension (6.3)	On nameplate
5	Body material designation: Material symbol (AISI, ASME, ASTM, ISO) Note: When body is fabricated of more than one type of steel, the end connection material governs marking.	On both body and nameplate. Melt identification (i.e., cast or heat number) on body only
6	Bonnet/cover material designation: Material symbol (AISI, ASME, ASTM, ISO)	On bonnet/cover, including melt identification (i.e., heat number)
7	Trim identification: Symbols indicating material of stem and sealing faces of closure members if different from that of body. Note: MSS-SP-25 gives guidance on marking.	On nameplate
8	Nominal valve size: a) Full-opening valves: nominal valve size b) Reduced-opening valves: shall be marked as specified in *Clause 6.2.*	On body or nameplate or both (where practicable)
9	Ring joint groove number	On valve flange edge
10	SMYS and minimum wall thickness	On body weld bevel ends
11	Flow direction (for check valves only)	On body of uni-directional valves only
12	Seat sealing direction	Separate identification plate on valve body
13	Unique serial number	On both body and nameplate
14	Date of manufacture (month and year)	On nameplate
15	ISO 14313	On nameplate

Table 12.1 Valve Marking

13 Storage and Shipping

13.1 Shipping

Each container shall be identified with its contents as well as the purchase order number.

Valves shall be protected from damage during shipping.

When a manufacturer transports by sea, all valves and their components shall be supplied as below deck cargo in waterproof containers.

All non-corrosion-resistant valves shall be primed and/or painted externally in accordance with the manufacturer's standards.

Stainless-steel valves shall not be painted.

Flange faces, weld bevel ends and exposed stems shall not be painted.

13.2 Corrosion Prevention

Prior to shipment, parts and equipment, which have bare metallic surfaces, shall be protected with a rust preventative, which will provide protection at temperatures up to 50°C (122°F).

13.3 Openings

Valve flanged and welding ends shall be blanked off to protect the surfaces, welding ends and valve internals during shipment and storage. Protective covers shall be made of wood, wood fiber, plastic or metal and shall be securely attached to the valve ends by bolting, steel straps, steel clips or suitable friction-locking devices. The design of the covers shall prevent the valves from being installed unless the covers have been removed.

Plug, ball and reverse-acting through-conduit gate valves shall be shipped in the fully open position, unless fitted with a fail-to-close actuator.

Slab-gate valves shall be shipped with the gate in the fully closed position. Check valves shall be shipped with the disc supported or secured during transit.

Valves provided with stem extensions without an operating mechanism shall have the annular space closed and the stem extension secured against the outer housing.

14 Documentation

14.1 Bid Submission Documents and Information Package

The Vendor is advised that a complete documents and information package is a bid-qualifying requirement.

The elements of this package shall include:

a) Verification of Enbridge valve specification number and revision

b) Verification of conformance to EES105 and the Application Datasheet(s)

A copy of the Application Datasheet shall accompany each valve offering. Note that the Application Datasheet may apply to one valve offering or a group of identical valve offerings.

c) Alternative Features

Where the Vendor is proposing an alternative feature, the Vendor shall also provide an explanation of the benefits of the alternative.

Alternatives include exceptions and substitutions.

d) Manufacturer's Quality Control Plan

The Plan shall be precisely the Plan for use on the referenced valve order. General plans are not acceptable.

Industry certificates of conformance and quality program audit certificates shall be supplied.

e) Coating or Painting Procedures

f) Manufacturing and valve assembly locations, including third party service providers

g) Valve Assembly Drawings

Valve assembly drawings including dimensions, weights, details of sealing design and materials, auxiliaries, stem extensions, drive train elements.

h) Volume of Body Cavity

i) Delivery Dates per Valve

j) Cost per Valve

Basic Valve	
Auxiliary Piping	
Stem Extension	
Gear Operator	
Electric Actuator Adaption	
Coating/Painting	
NDE and Pressure Testing	
Shipping	
Documentation and Other Costs	
TOTAL	

14.2 Post Award

The Vendor shall submit a minimum of the following for Company approval at an agreed upon date after award and prior to manufacture and assembly:

a) Dimensional outline drawings, cross-sectional drawings and detail drawings (see Clause 14.4 Vendor Documentation Schedule for details);

b) Material specifications for all components of the valve at the time of actual valve manufacture;

c) Details of transition pieces supplied by the Vendor;

d) Any proposed weld and heat treatment procedures;

e) Shipping weights, lengths and widths; and

f) Production schedule (every 2 weeks until shipment is complete).

14.3 Final Documentation

The documentation for valves shall include:

a) Operations and Maintenance Manuals;

b) Positive Material Identification (MTR);

c) Weld procedure specification (WPS);

d) Weld procedure qualification record (PQR);

e) Welder qualification record (WQR);

f) Records of test equipment calibration;

g) Mechanical test results as applicable;

h) Non-destructive examination records;

i) Melt identification certificates for body bonnet/cover(s) and end connector(s) traceable to the unique valve serial number;

j) All valve drawings;

k) Detailed parts lists;

l) Any other specific requirements listed in the purchase order;

m) Confirmation that the valve provided has been fabricated and shipped in accordance with the requirements of this specification and the purchase order;

n) Completed Maximo data sheet;

o) Serial number for tracing the valve bill of materials;

p) Charts for hydrostatic tests; and

q) Final QA/QC documentation package.

One copy of each of the above items is to be shipped with the valve. The remaining copies are to be shipped to the location listed in the purchase order as directed by the Company. Documentation shall be provided by the manufacturer in legible, retrievable and reproducible form, and free of damage.

14.4 Vendor Documentation Schedule

DATA AND DRAWINGS REQUIRED	Bid Proposal	Post Award	Shipment
	No. of Copies	No. of Copies	No. of Copies
1. Dimensioned Outline Drawings	1P (1E)	2P, 1E	2P, 1E
2. Cross Sectional Drawings	1P (1E)	2P, 1E	2P, 1E
3. Detail Drawings	1P (1E)	2P, 1E	2P, 1E
4. Assembly - Erect Drawings			
5. Foundation/Anchor Bolt Drawings			
6. Piping Drawings			
7. Wiring/Schematic Diagrams (Hydraulic)			
8. Parts List			2P
9. Priced Recommended Spare Parts List	1P (1E)		2P
10. Installation, Operations and Maintenance Manuals			2P
11. Equipment Data Sheets	1P (1E)	2P	2P
12. Shipping Weight(s)	1P (1E)	2P	2P
13. Manufacturers Test Reports			2P
14. Mill Test Certificates			2P
15. Nameplate Data		2P	2P
16. Surface Preparation QA/QC			
17. Hydrostatic Test Charts			2P
18. Materials Specification and Manufacturing Standard	2P (1E)	2P	2P
19. As-Built Drawings			
20. MAXIMO Information			
21.			
22.			

P – Print E – Electronic

Appendix I
Application Datasheet

Valve Application Datasheet (Page 1 of 2)

Date: (To be completed by Enbridge representative.)

Material Requisition No.								Revision:	
Quantity Required:									
Project Location:								☐ Canada	☐ USA
Project Name / Number:									
Description of Application:									
Functional Tags:									
Shipping Tags:									
Code: ☐ API 6D ☐ CSA Z245.15								Below Grade ☐ Yes	☐ No
Fluid: ☐ Oil ☐ NGL ☐ Refined Products								Ambient Temperature °C min /	°C max
Fluid Product Description									
Process Conditions	Temp (°C)	Vapor Pressure (kPa)	Viscosity (CP)	Density (kg/m^3)	Flow Rate (m^3/hr)	Pressure (kPa)	Solids %	Corrosives	
Minimum									
Normal									
Maximum									
Valve Size: mm / inch								**Port Size:** ☐ Full ☐ Reduced	5.1
Piping Class (PN) ANSI		Type			Valve Style (Clause 5.0)		Inlet	Outlet	
☐ (20) 150		☐ Gate					☐ FLG	☐ FLG	6.7
☐ (50) 300		☐ Globe					☐ WLD	☐ WLD	6.7
☐ (100) 600		☐ Plug					☐ RTJ	☐ RTJ	6.7
☐ (150) 900		☐ Check							
		☐ Ball							
Is pigging required? ☐ Yes ☐ No									6.6
Charpy V-notch test required? ☐ Yes Test Temperature:_____ ☐ No									7.1
Supplemental Information for Welded Valves (to be completed when specifying welded valves)									
Pipe Material and Grade									
Pipe OD mm (inch)									
Wall thickness mm (inch)									
Auxiliaries									
Pressure Relief (6.8) ☐ Yes ☐ No								Double Block and Bleed ☐ Yes	☐ No
Body Drain (6.9) ☐ Yes ☐ No								Position Indicator (6.12) ☐ Yes	☐ No
If pressure relief devices are required, are there special requirement for these devices? ☐ Yes ☐ No									
Additional valve support members? ☐ Yes ☐ No Description:									
Lifting Lugs ☐ Yes ☐ No									

Valve Application Datasheet (Page 2 of 2)

Drive Train Elements:					
Manual	☐ Yes	☐ No	☐ By Manufacturer	☐ By Others	
Electric	☐ Yes	☐ No	☐ By Manufacturer	☐ By Others	
Electric / Hydraulic	☐ Yes	☐ No	☐ By Manufacturer	☐ By Others	
Gear Operation	☐ Yes	☐ No	☐ By Manufacturer	☐ By Others	
Handwheel	☐ Yes	☐ No	☐ By Manufacturer	☐ By Others	
Handle / Lever	☐ Yes	☐ No	☐ By Manufacturer	☐ By Others	
Stem Extension Dimension	____mm/inch				
Valve Opening Centreline to:	☐ Grade	☐ Platform	☐ Manual operator handwheel	☐ Electric actuator adaptor	
Actuator Adaption	☐ Yes	☐ No	☐ By Manufacturer	☐ By Others	
Actuator Mounting	☐ Yes	☐ No	☐ By Manufacturer	☐ By Others	
Coating/Painting:					
Coating for below grade valve?	☐ Yes	☐ No	☐ N/A		
Painting for above grade valve?	☐ Yes	☐ No	☐ N/A		
Hydrostatic Testing:					
Hydrostatic Shell Test	Pressure:		Duration:		
Hydrostatic Seat Test	Pressure:		Duration:		
Gasket / O-Ring Material:	☐ Kalrez	☐ Nitrile	☐ Viton	☐ Other	7.2
Additional Notes:					
Reference Drawings:					
Prepared by: Engineer / Designer Name:					

Revision	Description	By	Reviewed	Approved	Date
A					

Appendix II
Dimension Tables

DIMENSION TABLES

DN (mm)	NPS (inches)	PN 20 to 100 (Class 150 to 600)	PN 150 (Class 900)
15	0.5	13	13
20	0.75	19	19
25	1	25	25
32	1.25	32	32
40	1.5	38	38
50	2	49	49
65	2.5	62	62
80	3	74	74
100	4	100	100
150	6	150	150
200	8	201	201
250	10	252	252
300	12	303	303
350	14	334	322
400	16	385	373
450	18	436	423
500	20	487	471
550	22	538	522
600	24	589	570
650	26	633	617
700	28	684	665
750	30	735	712
800	32	779	760
850	34	830	808
900	36	874	855
950	38	925	-
1000	40	976	-
1050	42	1020	-
1200	48	1166	-
1350	54	1312	-
1400	56	1360	-
1500	60	1458	-

Table A1.1 Minimum Bore for Full-Opening Valves (mm)

DN (mm)	NPS (Inches)	Raised Face A	Welding End B	Ring Joint C	Raised Face A	Welding End B	Ring Joint C
		PN 20	(Class 150)		PN 50	(Class 300)	
50	2	178	216	191	216	216	232
65	2 1/2	191	241	203	241	241	257
80	3	203	283	216	283	283	298
100	4	229	305	241	305	305	321
150	6	267	403	279	403	403	419
200	8	292	419	305	419	419	435
250	10	330	457	343	457	457	473
300	12	356	502	368	502	502	518
350	14	381	572	394	762	762	778
400	16	406	610	419	838	838	854
450	18	432	660	445	914	914	930
500	20	457	711	470	991	991	1010
550	22	-	-	-	1092	1092	1114
600	24	508	813	521	1143	1143	1165
650	26	559	864	-	1245	1245	1270
700	28	610	914	-	1346	1346	1372
750	30	610*	914	-	1397	1397	1422
800	32	711	965	-	1524	1524	1553
850	34	762	1016	-	1626	1626	1654
900	36	711**	1016	-	1727	1727	1756
		PN 100 (Class 600)			PN 150 (Class 900)		
50	2	292	292	295	368	368	371
65	2 1/ 2	330	330	333	419	419	422
80	3	356	356	359	381	381	384
100	4	432	432	435	457	457	460
150	6	559	559	562	610	610	613
200	8	660	660	664	737	737	740
250	10	787	787	791	838	838	841
300	12	838	838	841	965	965	968
350	14	889	889	892	1029	1029	1038
400	16	991	991	994	1130	1130	1140
450	18	1092	1092	1095	1219	1219	1232
500	20	1194	1194	1200	1321	1321	1334
550	22	1295	1295	1305	-	-	-
600	24	1397	1397	1407	1549	1549	1568
650	26	1448	1448	1461	* Through-conduit valves shall be 650 mm. ** Through-conduit valves shall be 800 mm.		
700	28	1549	1549	1562			
750	30	1651	1651	1664			
800	32	1778	1778	1794			
850	34	1930	1930	1946			
900	36	2083	2083	2099			

Table A1.2 Gate Valves-Face-To-Face (A) and End-To-End (B and C) Dimensions (mm)

		Short-pattern			Reduced			Venturi			Round-port, full-bore		
DN (mm)	**NPS** (Inches)	**Raised Face** A	**Welding End** B	**Ring Joint** C	**Raised Face** A	**Welding End** B	**Ring Joint** C	**Raised Face** A	**Welding End** B	**Ring Joint** C	**Raised Face** A	**Welding End** B	**Ring Joint** C
		PN 20 (Class 150)											
50	2	178	267	191	-	-	-	-	-	-	267	-	279
65	2 1/2	191	305	203	-	-	-	-	-	-	298	-	311
80	3	203	330	216	-	-	-	-	-	-	343	-	356
140	4	729	356	241	-	-	-	-	-	-	432	-	445
150	6	267	457	279	394	-	406	-	-	-	546	-	559
200	8	292	521	305	457	-	470	-	-	-	622	-	635
250	10	330	559	343	533	-	546	533	559	546	660	-	673
300	12	356	635	368	610	-	622	610	635	622	782	-	775
350	14	-	-	-	-	-	-	686	686	699	-	-	-
400	16	-	-	-	-	-	-	782	762	775	-	-	-
450	18	-	-	-	-	-		864	864	876	-	-	-
500	20	-	-	-	-	-	-	914	914	927	-	-	-
600	24	-	-	-	-	-	-	1067	1067	1080	-	-	-
		PN 50 (Class 300)											
54	2	216	267	232	-	-	-	-	-	-	283	283	298
65	2 1/2	241	304	257	-	-	-	-	-	-	330	330	346
80	3	283	330	298	-	-	-	-	-	-	387	387	403
100	4	305	356	321	-	-	-	-	--	-	457	457	473
150	6	403	457	419	403	-	419	403	457	419	559	559	575
200	8	419	521	435	502	-	518	419	521	435	686	686	702
250	10	457	559	473	568	-	584	457	559	473	826	826	841
300	12	502	635	518	-	-	-	502	635	518	965	965	981
950	14	-	-	-	-	-	-	762	762	778	-	-	-
400	16	-	-	-	-	-	-	838	838	854	-	-	-
450	18	-	-	-	914	-	930	914	914	930	-	-	-
500	20	-	-	-	991	-	1010	991	991	1010	-	-	-
550	22	-	-	-	1092	-	1114	1092	1092	1114	-	-	-
600	24	-	-	-	1143	-	1165	1143	1143	1165	-	-	-
650	26	-	-	-	1245	-	1270	1245	1245	1270	-	-	-
700	28		-	-	1346	-	1372	1346	1346	1372	-	-	-
750	30	-	-	-	1 397	-	1422	1397	1397	1422	-	-	-
800	32	-	-	-	1524	-	1553	1524	1524	1553	-	-	-
850	34	-	-	-	1626	-	1654	1626	1626	1654	-	-	-
900	36	-	-	-	1727	-	1756	1727	1727	1756	-	-	-

Table A1.3 Plug Valves - Face-to-Face (A) and End-to-End (B and C) Dimensions (mm)

		Reduced			Venturi			Round-port, full-bore		
DN (mm)	**NPS** (inches)	**Raised Face** A	**Welding End** B	**Ring Joint** C	**Raised Face** A	**Welding End** B	**Ring Joint** C	**Raised Face** A	**Welding End** B	**Ring Joint** C
		PN 100 (Class 600)								
50	2	292	292	295	-	-	-	330	-	333
65	2 1/2	330	330	333	-	-	-	381	-	384
80	3	356	356	359	-	-	-	445	-	448
100	4	432	432	435	-	-	--	508	559	511
150	6	559	559	562	559	559	562	660	711	664
200	8	660	660	664	660	660	664	794	845	797
250	10	787	787	791	787	787	791	940	1016	943
300	12	-	-	-	838	838	841	1067	1067	1070
350	14	-	-	-	889	889	892	-	-	-
400	16	-	-	-	991	991	994	-	-	-
450	18	-	-	-	1092	1092	1095	-	-	-
500	20	-	-	-	1194	1194	1200	-	-	-
550	22	-	-	-	1295	1295	1305	-	-	-
600	24	-	-	-	1397	1397	1407	-	-	-
650	26	-	-	-	1448	1448	1461	-	-	-
750	30	-	-	-	1651	1651	1664	-	-	-
800	32	-	-	-	1778	1778	1794	-	-	-
850	34	-	-	-	1930	1930	1946	-	-	-
900	36	-	-	-	2083	2083	2099	-	-	-
		PN 150 (Class 900)								
50	2	368	-	371	-	-	-	381	-	384
65	2 1/2	419	-	422	-	-	-	432	-	435
80	3	381	381	384	-	-	-	470	-	473
100	4	457	457	460	-	-	-	559	-	562
150	6	610	610	613	610	610	613	737	-	740
200	8	737	737	740	737	737	740	813	-	816
250	10	838	838	841	838	838	841	965	-	968
300	12	-	-	-	965	965	968	1118	-	1121
400	16	-	-	-	1130	1130	1140	-	-	-

Table A1.3 (continued)

		Full-bore and Reduced-bore			Short-pattern, full-bore and reduced-bore		
DN (mm)	**NPS** (inches)	**Raised Face** A	**Welding End** B	**Ring Joint** C	**Raised Face** A	**Welding End** B	**Ring Joint** C
		PN 20 (Class 150)					
50	2	178	216	191	-	-	-
65	2 ½	191	241	203	-	-	-
80	3	203	283	216	-	-	-
100	4	229	305	241	-	-	-
150	6	394	457	406	267	403	279
200	8	457	521	470	292	419	305
250	10	533	559	546	330	457	343
300	12	610	635	622	356	502	368
350	14	686	762	699	-	-	-
400	16	762	838	775	-	-	-
450	18	864	914	876	-	-	-
500	20	914	991	927	-	-	-
550	22	-	-	-	-	-	-
600	24	1067	1143	1080	-	-	-
650	26	1143	1245	-	-	-	-
700	28	1245	1346	-	-	-	-
750	30	1295	1397	--	-	-	-
800	32	1372	1524	-	-	-	-
850	34	1473	1626	-	-	-	-
900	36	1524	1727	-	-	-	-
950	38	-	-	-	-	-	-
1000	40	-	-	-	-	-	-
1100	42	-	-	-	-	-	-
1200 1400	48 54	-	-	-	-	-	-
1500	60	-	-	-	-	-	-

Table A1.4 Ball Valves-Face-to-Face (A) and End-to-End (B and C) Dimensions (mm)

		Full-bore and reduced-bore			Short-pattern, full-bore And reduced-bore		
DN (mm)	**NPS** (Inches)	**Raised Face** A	**Welding End** B	**Ring Joint** C	**Raised Face** A	**Welding End** B	**Ring Joint** C
		PN 50 (Class 300)					
50	2	216	216	232	-	-	-
65	2 1/2	241	241	257	-	-	-
80	3	283	283	298	-	-	-
100	4	305	305	321	-	-	-
150	6	403	403	419	-	-	-
200	8	502	521	518	419	419	435
250	10	568	559	584	457	457	473
300	12	648	635	664	502	502	518
350	14	762	762	778	-	-	-
400	16	838	838	854	-	-	-
450	18	914	914	930	-	-	-
500	20	991	991	1010	-	-	-
550	22	1092	1092	1114	-	-	-
600	24	1143	1143	1165	-	-	-
650	26	1245	1245	1270	-	-	-
700	28	1346	1346	1372	-	-	-
750	30	1397	1397	1422	-	-	-
800	32	1524	1524	1553	-	-	-
850	34	1626	1626	1654	-	-	-
900	36	1727	1727	1756	-	-	-
950	38	-	-	-	-	-	-
1000	40	-	-	-	-	-	-
1100	42	-	-	-	-	-	-
1200	48	-	-	-	-	-	-
1400	54	-	-	-	-	-	-
1500	60	-	-	-	-	-	-

Table A1.4 *(continued)*

DN (mm)	**NPS** (Inches)	**Raised Face** A	**Welding End** B	**Ring Joint** C
		PN 100 (Class 600)		
50	2	292	292	295
65	2 1/ 2	330	330	333
80	3	356	356	359
100	4	432	432	435
150	6	559	559	562
200	8	660	660	664
250	10	787	787	791
300	12	838	838	841
350	14	889	889	892
400	16	991	991	994
450	18	1092	1092	1095
500	20	1194	1194	1200
550	22	1295	1295	1305
600	24	1397	1397	1407
650	26	1448	1448	1461
700	28	1549	1549	1562
750	30	1651	1651	1664
800	32	1778	1778	1794
850	34	1930	1930	1946
900	36	2083	2083	2099
950	38	-	-	-
1000	40	-	-	-
1100	42	-	-	-
1200	48	-	-	-

Table A1.4 *(continued)*

		PN 20 (Class 150)			PN 50 (Class 300)			PN 100 (Class 600)		
DN (mm)	NPS (Inches)	Raised Face A	Welding End B	Ring Joint C	Raised Face A	Welding End B	Ring Joint C	Raised Face A	Welding End B	Ring Joint C
50	2	203	203	216	267	267	283	292	292	295
66	2 1/2	216	216	229	292	292	308	330	330	333
80	3	241	241	254	318	318	333	356	356	359
100	4	292	292	305	356	356	371	432	432	435
150	6	356	356	368	445	445	460	559	559	562
200	8	495	495	508	533	533	549	660	660	664
250	10	622	622	635	622	622	638	787	787	791
300	12	699	699	711	711	711	727	838	838	841
350	14	787	787	800	838	838	854	889	889	892
400	16	864	864	876	864	864	879	991	991	994
450	18	978	978	991	978	978	994	1092	1092	1095
500	20	978	978	991	1016	1016	1035	1194	1194	1200
550	22	1067	1067	1060	1118	1118	1140	1295	1295	1305
600	24	1295	1295	1308	1346	1346	1368	1 397	1397	1407
650	26	1295	1295	-	1346	1346	1372	1448	1448	1461
700	28	1448	1448	-	1499	1499	1524	1600	1600	1613
750	30	1524	1524	-	1594	1594	1619	1651	1651	1664
900	36	1956	1956	-	2083	2083	-	2083	2083	-
950	38	-	-	-	-	-	-	-	-	-
1000	40	-	-	-	-	-	-	-	-	-
1100	42	-	-	-	-	-	-	-	-	-
1200	48	-	-	-	-	-	-	-	-	-
1400	51	-	-	-	-	-	-	-	-	-
1500	60	-	-	-	-	-	-	-	-	-

Table A1.5 Swing Check Valves, Reduced- and Full-Opening Types, Face-to-Face (A) and End-to-End (B and C) Dimensions (mm)

DN (mm)	NPS (inches)	PN 150 (Class 900)		
		Raised Face A	Welding End B	Ring Joint C
50	2	368	368	371
65	2 1/2	419	419	422
80	3	381	381	384
100	4	457	457	460
150	6	610	610	613
200	8	737	737	740
250	10	838	838	841
300	12	965	965	968
350	14	1029	1029	1038
400	16	1130	1130	1140
450	18	1219	1219	1232
500	20	1321	1321	1334
600	24	1549	1549	1568

Table A1.5 *(concluded)*

		PN 20 (Class 150)		PN 50 (Class 300)		PN 100 (Class 600)		PN 150 (Class 900)	
DN (mm)	**NPS** (inches)	**Short-Pattern**	**Long-Pattern**	**Short-Pattern**	**Long-Pattern**	**Short-Pattern**	**Long-Pattern**	**Short-Pattern**	**Long-Pattern**
50	2	19	60	19	60	19	60	19	70
65	2 1/2	19	67	19	67	19	67	19	83
80	3	19	73	19	73	19	73	19	83
100	4	19	73	19	73	22	79	22	102
150	6	19	98	22	98	29	137	35	159
200	8	29	127	29	127	38	165	44	206
250	10	29	146	38	146	57	213	57	241
300	12	38	181	51	181	60	229	NOTE	292
350	14	44	184	51	222	67	273	NOTE	356
400	16	51	191	51	232	73	305	NOTE	384
450	18	60	203	76	264	83	362	NOTE	451
500	20	64	219	83	292	92	368	NOTE	451
600	24	NOTE	222	NOTE	318	NOTE	438	NOTE	495
750	30								-
900	36								-
1100	42								-
1200	48								-
1400	54								-
1500	60								-

Table A1.6 Single- and Dual-Plate, Long- and Short-Pattern, Wafer-Type Check Valves-Face-to-Face Dimensions (mm)

Appendix III
CSA Z245.15 Alternatives (Canadian Installations)

CSA Z245.15 ALTERNATIVES (CANADIAN INSTALLATIONS)

For valves that will be installed In Canada:

Manufacturer shall ensure that the design of all pressure components is registered with a Canadian Registration Number (CRN) in accordance with the Alberta Boiler and Pressure Vessel Act and its regulations, (except when "CRN registration not required" is stated in the purchase order).

The requirements for heat analysis shall be as given in *Table 17.1*.

For grades 290 and higher, at a frequency of one test per heat, a product analysis shall be determined by the manufacturer. The requirements for product analysis shall be as given in *Table 17.1*.

Grades	**Maximum Carbon Equivalent*(%)**	
Grade 290 and Higher	**0.5**	
	Maximum Permitted (%)	
Element	**Lower than Grade 290 Heat Analysis**	**Grade 290 or Higher Product Analysis**
Carbon	0.35	0.30
Manganese	1.35	1.60
Phosphorus	0.05	0.05
Sulfur	0.06	0.06
Silicon	0.35	0.50
Copper	-	1.50
Nickel	-	1.00
Chromium	-	0.25
Molybdenum	-	0.25
Vanadium	-	0.13
Niobium	-	0.10
Boron	-	0.001

Table 17.1 Chemical Composition Limits for Heat and Product Analysis

*The carbon equivalent shall be determined from the product analysis by using the following formula:

C.E. = C + F {Mn/6 + Si/24 + Cu/15 + Ni/20 + (Cr + Mo + V + Nb)/5) + 5B}

Where F is a compliance factor that is dependent on carbon content and is given in Table 17.2.

Notes:

(1) The chemical requirements of this table are not intended to represent the composition of any heat of steel but to record the maximum permissible amounts of individual elements.

(2) Niobium is also known as columbium.

Carbon (%)	Compliance factor (F)	Carbon (%)	Compliance factor (F)	Carbon (%)	Compliance factor (F)
< 0.06	0.53	0.11	0.70	0.17	0.94
0.06	0.54	0.12	0.75	0.18	0.96
0.07	0.56	0.13	0.80	0.19	0.97
0.08	0.58	0.14	0.85	0.20	0.98
0.09	0.62	0.15	0.88	0.21	0.99
0.10	0.66	0.16	0.92	> 0.21	1.00

Table 17.2 Compliance Factor (F) – Carbon Equivalent Formula

The following paragraph numbers refer back to the main body of this specification.

A.6.0 Noise

Where noise levels are a consideration, on request from the purchaser, the manufacturer shall provide estimated noise levels for the flow conditions specified.

A.6.7 Wafer-Type Valve Ends

Wafer-type valves shall be supplied with finished ends compatible with the specified matching flanges.

A.6.7.1 Flanged Ends

End flanges shall be fully machine-finished on die joint side. The bearing surfaces for bolting shall be parallel within 1° to the flange face; back facing or spot facing may be required to accomplish such parallelism. Casket contact surfaces for raised faces shall have a finish in accordance with the requirements of *CSA Z245.12*.

A.6.7.2 Welded Ends

The land shall be machined flat within 0.8 mm.

A.6.12 Position Indicator

Where the valve-closing direction is other than clockwise, the valve-closing direction shall be clearly marked.

A.6.13 Handle Extensions

It shall be permissible for plug- and ball-valve wrenches to be of an integral design or consist of a head that fits on an obturator stem designed to take an extended handle. Such head designs shall provide for permanent attachment of the extended section. Where specified in the purchase order, handle extensions shall be furnished.

A6.13.2 Sealant Fittings

Valves that rely on sealant as a primary seal or a secondary backup seal shall have provision for injection of sealant with fittings that meet the following requirements:

a) The lubricant fitting shall be of the giant button-head type, of a one-piece body design, and shall be of a size consistent with standard North American lubricating devices.
Note: fittings with significant dimensions conforming to those found on Stewart-Warner "Alemite" giant button-head fittings are considered standard.

b) The lubricating part shall be protected by a ball check device independent of the lubricating fitting, in order to provide for safe removal or replacement of the fitting when a valve is under line pressure conditions.

c) The number and locations of the fittings shall be such as to provide proper distribution and sufficient deposition of the sealant.

d) Valves that are intended for buried service or that are intended to be otherwise inaccessible shall have sealant piping extended to a convenient and accessible location. The piping shall be adequately supported and made of a material compatible with the valve and shall be capable of withstanding the maximum line pressure plus the sealant injection pressure.

A.6.17.2 Tension Tests

A.6.17.2.1 General

Except as otherwise required by this Standard, test specimens and testing procedures shall be in accordance with the requirements of *ASTM A370*. Testing shall be conducted with the test specimens at room temperature.

A.6.17.2.2 Requirements

The tensile properties of each pressure-containing part in the valve shall be in accordance with the requirements of the applicable ASTM Material Standard or specification.

A.6.18 Stem Packing

Stem packing shall be replaceable.

Note: Not all valve designs allow the packing to be replaced under line pressure or without removing the top works.

A.7.1 Material Specification

Where sour service is specified in the purchase order, valves shall be in accordance with the requirements of *Clause A.7.1*

Note: Materials, including welding consumables, and manufacturing procedures should be selected in order to avoid microstructures in the weld metal, heat-affected zones, and parent metal that are detrimental for use in sour service.

A.7.1.2

Valves shall be in accordance with the requirements of *NACE MR0175.*

A.7.1.3

Unless otherwise specified in the purchase order, pressure-containing steel bolting shall be in accordance with the requirements of ASTM A193, Grade B7M, or A320, Grade L7M, and nuts shall be in accordance with the requirements of ASTM A 194, Grade 2HM or Grade 7M.

A.7.1.4

Unless otherwise specified in the purchase order, the hardness of each pressure-containing fastener not covered by a Standard listed in *Clause 13.3* shall be determined in accordance with the testing requirements specified for Grade B7M in ASTM A193 and shall not exceed HRC 22.

A.7.1.5

For each welding procedure specification, a separate procedure qualification record shall be developed for wrought material welds, cast material welds, and cast-to-wrought material welds, as applicable.

A.7.1.6

The welding procedure shall be qualified under actual production conditions or under simulated production conditions including weld cooling rates.

A.7.1.7

When the weld procedure does not include post-weld heat treatment, microhardness traverses on a cross-section of the procedure qualification weld required by *Clauses 7.7,* be performed in accordance with the requirements of *ASTM E384*. The location and minimum number of hardness impressions shall be as shown in Appendix VI. The microhardness shall not exceed 248, using a Vickers indenter with a load of 500 g or less. Conversion from other hardness scales shall not be permitted.

A.7.2 Stem Packing

Stem packing shall be replaceable.

Note: Not all valve designs allow the packing to be replaced under line pressure or without removing the top works.

A7.3 Stem Protection

The stem of a rising-stem gate valve shall be protected by a dustproof enclosure.

A7.7 Toughness Test Requirements – Materials

The test temperature shall be as specified in the purchase order, except that it shall be permissible for a lower test temperature to be used provided that the specified absorbed energy requirements are met.

A.7.7 Toughness Test Requirements

The absorbed energy (based upon full-size test specimens) for each Charpy V-notch impact test shall be equal to or greater than

a) 18 J, for parts that are lower than Grade 359;

b) 27 J, for parts that are Grade 359 or higher; or

c) Such higher value as is specified in the purchase order.

A9.1 Quality Control

The manufacturer shall have a documented quality program that is in accordance with the requirements of one or more of the following:

a) One of the CAN/CSA-ISO 9000 Standards;

b) One of the ISO 9000 Standards; or

c) The API Q1 Specification.

Valves shall be free of defects and shall have a competently produced finish.

A.9.2.4 Temperature – Measuring Devices

Where pressure recorders or gauges are used, the pressure range of the instrument shall not exceed twice the shell test pressure. Where temperature charts are used, the temperature range shall be capable of indicating 1 °C fluctuations.

A.9.0.1 Plant Inspection

Finished valves shall be free, both internally and externally, of loose mill scale, foreign matter, oil, and grease, and shall be clean and dry for final inspection. Valves shall be visually inspected to detect defects and to determine compliance with the dimensional and work quality requirements.

A.9.0.2 Inspection Notice

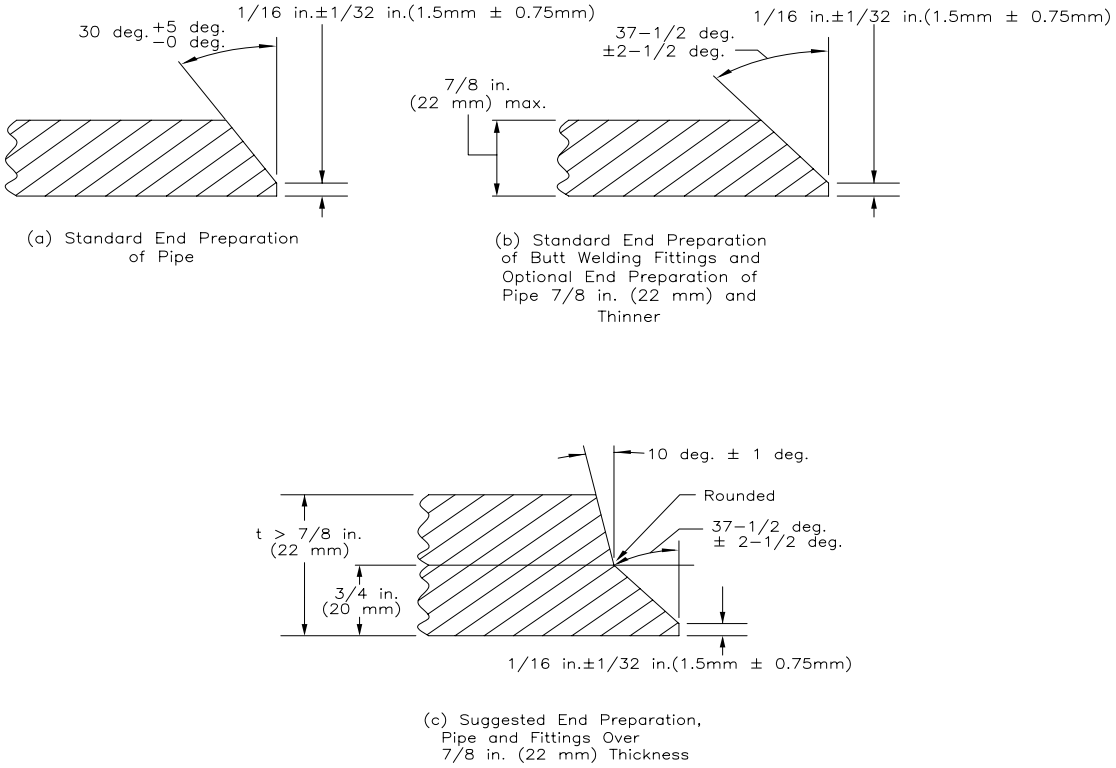
Where it is specified in the purchase order that the inspector representing the purchaser intends to inspect the valves or witness the tests at the manufacturer's plant, the manufacturer shall give the purchaser reasonable notice of the production schedule.

A.9.0.3 Plant Access

The inspector representing the purchaser shall have unrestricted entry at all times, while work on the purchaser's order is being performed, to all parts of the manufacturer's plant concerned with the manufacture of the valves ordered. The manufacturer shall afford the inspector all reasonable facilities to be satisfied that the valves are being manufactured, sampled, tested, and inspected in accordance with the requirements of this Standard and the purchase order. Inspections shall be conducted without interfering unnecessarily with the operation of the plant

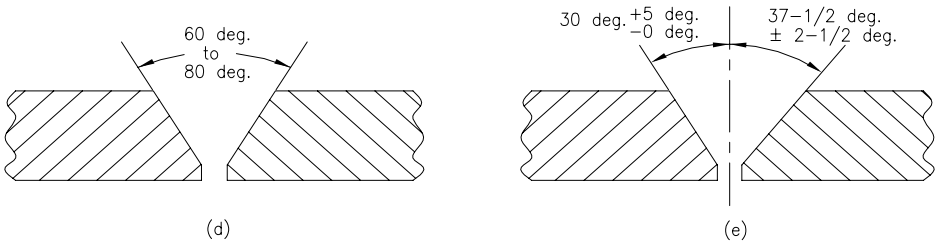
Appendix IV
Welded Ends

WELDED ENDS



Standard End Preparation (a), (b), and (c)

Figure A5.1-1 Acceptable Butt Welded Joint Design for Equal Wall Thicknesses



Acceptable Combinations of Pipe and Preparations (d), (e), and (f)

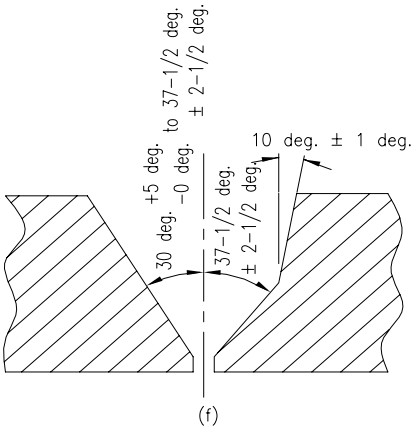


Figure A5.1-1 Acceptable Butt Welded Joint Design for Equal Wall Thicknesses (continued)

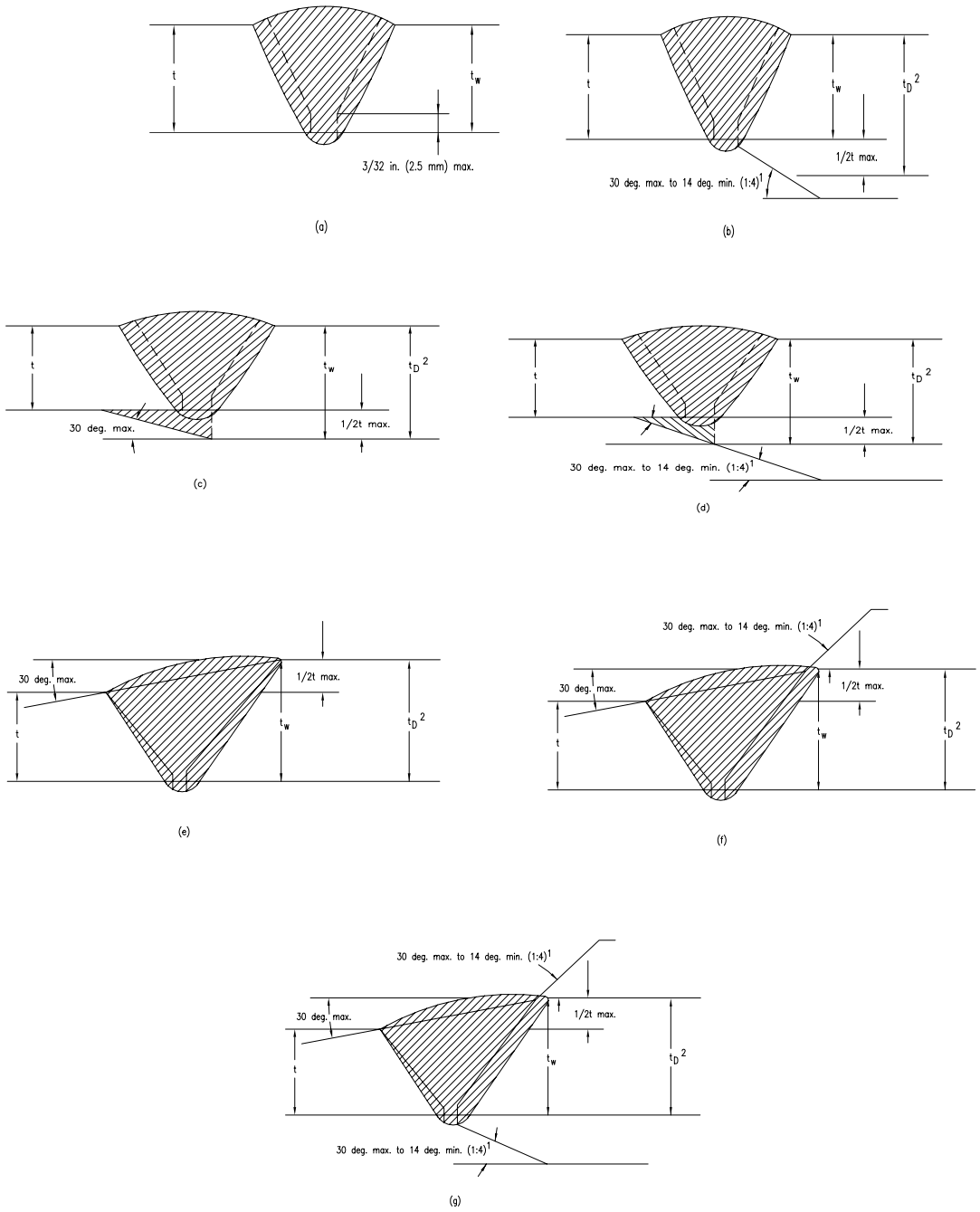
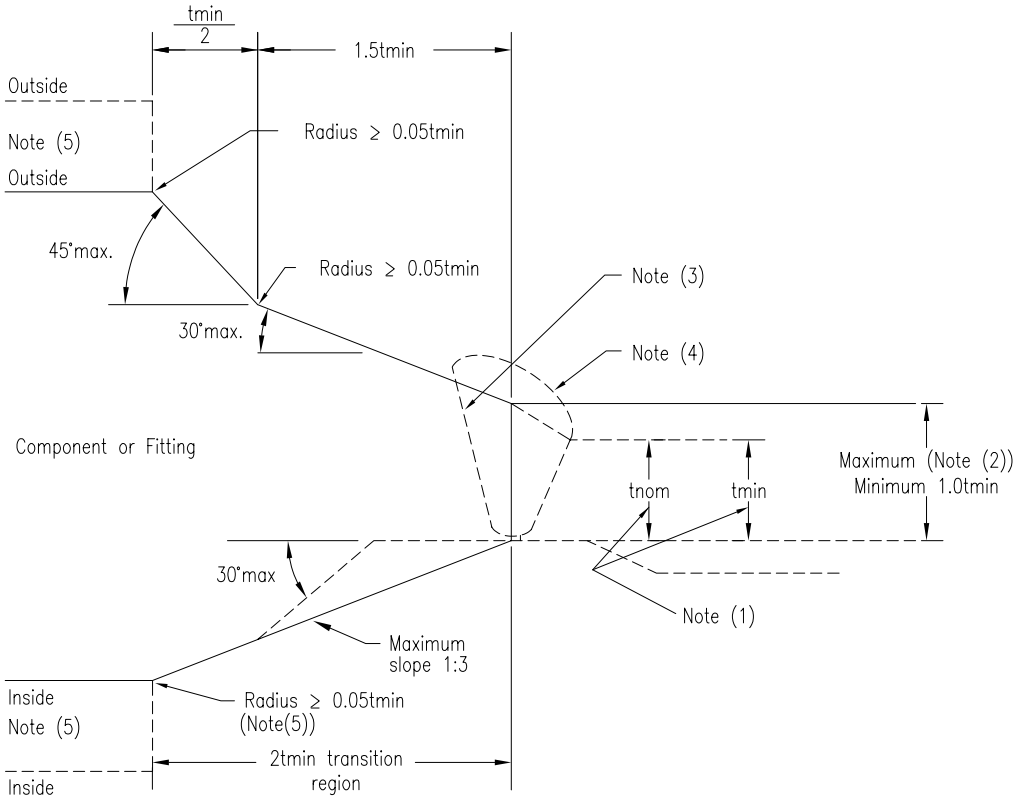


Figure A5.1-2 Acceptable Butt Welded Joint Design for Unequal Wall Thicknesses



NOTES:

(1) The value of t_{min} is whichever of the following is applicable:

(a) The minimum ordered wall thickness of the pipe to include pipe that is purchased to a nominal wall thickness with an under-tolerance other than 12.5%

(b) 0.875 times the nominal wall thickness of pipe ordered to a pipe schedule wall thickness that has an under-tolerance of 12.5%

(c) The minimum ordered wall thickness of the cylindrical welding end of a component or fitting (or the thinner of the two) when the joint is between two components

(2) The maximum thickness at the end of the components is:

(a) The greater of t_{min} + 4 mm (0.16 in.) or $1.15t_{min}$ when ordered on a minimum wall basis

(b) The greater of t_{min}+ 4 mm (0.16 in.) or $1.10t_{nom}$ when ordered on a nominal wall basis

(3) Weld bevel shown is for illustration only.

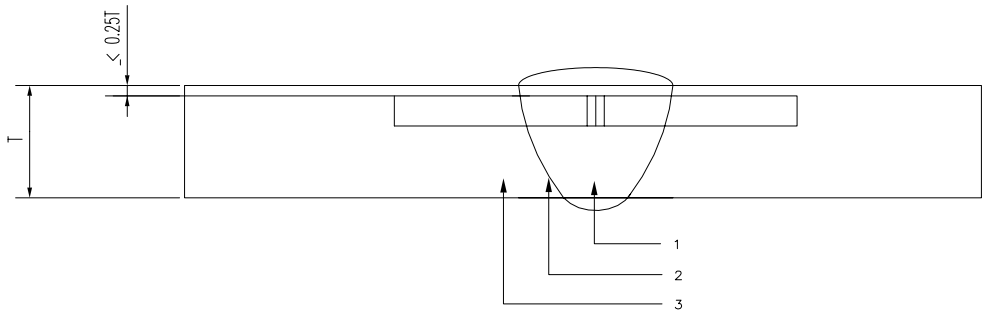
(4) The weld reinforcement permitted by applicable code may lie outside the maximum envelope.

(5) Where transitions using maximum slope do not intersect inside or outside surface, as shown by phantom outlines, maximum slopes shown or alternate radii shall be used.

Figure A5.2 Maximum Envelope for Welding End Transitions

Appendix V
Impact Testing Figures

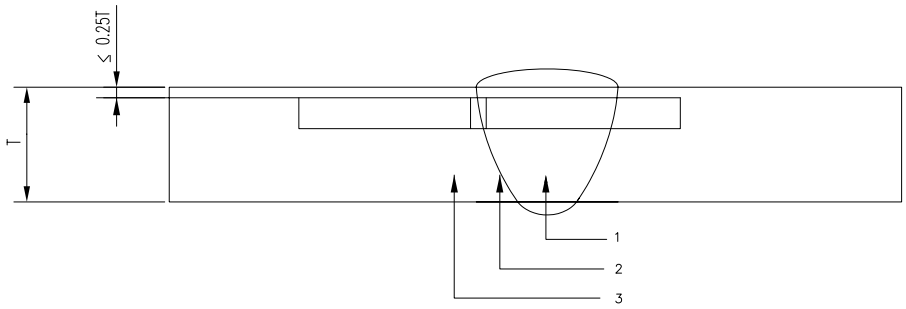
IMPACT TESTING FIGURES



Key:

1 Weld metal
2 Heat-affected zone
3 Base metal

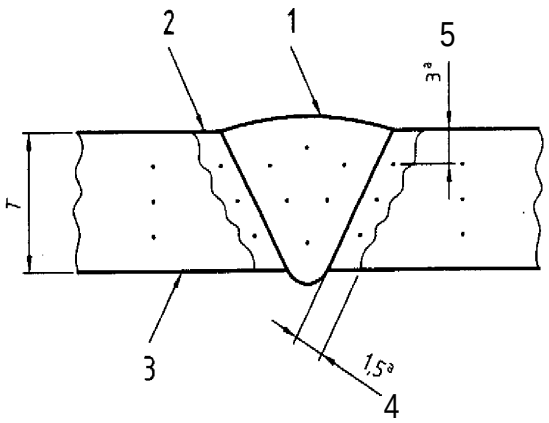
Figure A6.1 Charpy V-notch Weld Metal (WM) Specimen Location



Key:

1 Weld metal
2 Heat-affected zone
3 Base metal

Figure A6.2 Charpy V-notch Heat-affected Zone (HAZ) Specimen Location



Key:

1 Weld metal
2 Heat-affected zone
3 Base metal
4 1.5 mm (typical)
5 3.0 mm (typical)

Figure A6.3 Hardness Survey Specimen Location